APPENDIX D

SYSTEM MODEL ACCEPTABILITY REVIEW TM

Technical Memorandum

City of Milpitas – Sewer Master Plan

Subject:	Sanitary Sewer System Model Acceptability Review
Prepared For:	Jorge Bermudez
Prepared By:	Helene Kubler
Reviewed By:	Justine Faisst
CC:	File, Marilyn Nickel, Tom Richardson
Date:	July 2001 (DRAFT) December 2002 (FINAL)
Reference:	051.0080

The City's wastewater system model (Hydra Version 6.0) was completed in 1999. It was converted from the wastewater system model (SANSYS) created by Carollo Engineers in 1994. The 1999 model was not calibrated.

A first step in the calibration process is to perform a physical system model acceptability review, i.e. verify the accuracy of the manhole and pipe information. The information of primary concern is the manhole rim and pipe invert elevations, pipe sizes, and missing pipes. The City has already started crosschecking the integrity of the Hydra model. A table indicating the corrections and revisions done to-date to sewer inverts by the City is available. The objective of the current effort is to identify the remaining inaccuracies.

This memorandum is a summary of the model acceptability review performed as part of the wastewater system model development. It provides a list of the inaccuracies that were identified and summarizes what should be done to correct these inaccuracies.

This TM is organized as follows:

Manhole Rim Elevation Inaccuracies
Pipe Invert Elevation Inaccuracies
Pipe Size Inaccuracies
Missing Pipes
Conclusions

Manhole Rim Elevation Inaccuracies

Carollo Engineers used data files from the Sewer Information Management and Maintenance System furnished by the City to input rim elevation in the SANSYS model. The manhole rim elevations were unchanged when SANSYS was converted to Hydra. The modeled rim elevations were not updated to account for subsidence that severely impacted the City for the past decades. This is a reasonable assumption in so far as the modeled rim elevation does not intervene in the hydraulic profile computation. Consequently, only "abnormal" rim elevations, such as rim elevation lower than invert elevation or ground level going up and down, were identified and corrected for the purpose of the Sewer Master Plan. A new manhole rim elevation survey, done by aerial photograph, has been completed recently. According to the City staff, the accuracy of this survey is within 3 centimeters (1.2 inches). This survey will provide updated rim elevation for the manholes that require adjustment, but was not available at this time.

The Hydra model was thoroughly checked for manholes with "abnormal" rim elevation, such as rim elevation below invert elevation. Table 1 provides a list of the manholes requiring rim elevation corrections. The "abnormal" rim elevations that were identified are typically due to data entry errors in the model.

Through a later evaluation, discrepancies of about 1-2 feet between the rim elevation in Hydra and on the sewer maps were identified (e.g. manholes on McCarthy Ranch boulevard). The model was not checked and/or corrected for these errors since the sewer capacity calculated using the hydraulic model is not impacted by the rim elevation information. However, the potential for manhole overflow is established based on how the modeled hydraulic gradeline (HGL) compares with the rim elevation. When running the analysis and identifying manholes showing potential for overflows, the error in rim elevation should be accounted for. This could be done for example by defining a manhole overflow as follows: the computed HGL is *within 1 or 2 feet of the surface* (instead of "*at the surface*").

Once the rim elevation information from the recent survey becomes available through the GIS database, the City should update the rim elevations in the hydraulic model.

Pipe Invert Elevation Inaccuracies

Carollo Engineers used data from the sewer 1"=100' maps furnished by the City to input invert elevation in the SANSYS model. The sewer maps were created in 1967 (34 years old) and include projects that have been constructed since then. No field verification of the invert elevations was performed. The potential changes in invert elevation due to subsidence are not reflected on the sewer maps. Subsidence, particularly if it is uneven, could change the slope of pipes and consequently, the conveyance capacity of these pipes.

For the purpose of this TM, only "abnormal" invert elevations, such as invert above ground or negative slopes, were identified and corrected. It was agreed that the he subsidence impact on pipe invert elevation and pipe slope would not be evaluated for the purpose of the Sewer Master Plan.

The Hydra model was thoroughly checked for pipes and manholes with "abnormal" invert elevation. Table 2 provides a list of pipes requiring invert elevation corrections.

The "abnormal" invert elevations that were identified are typically due:

- Errors in the conversion from the pipe slope in SANSYS to invert elevation in Hydra, which are corrected by inputting the invert elevation value shown on the sewer maps; or,
- Errors in invert elevation in the sewer maps, which requires conducting a field investigation to be corrected.

Pipe Size Inaccuracies

Carollo Engineers used as-built information from the sewer system 1"=100' maps as the pipe size database. The pipe sizes were unchanged when SANSYS was converted to Hydra. Pipe sizes in the model that were not consistent with the pipe sizes shown on the sewer map were identified. Table 3 provides a list of pipes requiring diameter corrections.

The identified inaccuracies are typically due to data entry errors in the model. They will be corrected by inputting the pipe diameter shown on the sewer map or provided by the City staff.

Missing Pipes

Pipes 10 inches in diameter and larger that are shown on the sewer maps. Those not included in the model were identified. Table 4 provides a description of the missing pipes.

The missing pipes will be created in Hydra based on the data provided in the existing sewer maps. New trunk sewers and mains 12 inches in diameter and larger that were constructed as part of the capital improvement program since 1994 Master Plan will also be created in Hydra based on as-built information.

Conclusions

Most of the inaccuracies that were previously identified can be corrected based on available data, i.e. sewer maps and as-built, and input from City staff.

The model will not be checked and/or corrected for discrepancies in rim elevation with the sewer maps. However, the potential for manhole overflow is established based on how the modeled hydraulic gradeline (HGL) compares with the rim elevation. When running the analysis and identifying manholes showing potential for overflows, the discrepancies in rim elevation should be accounted for. Defining a manhole overflow as follows will allow accounting for these discrepancies: the computed HGL is *within 3 feet of the surface* (instead of "*at the surface*").

Once the rim elevation information from the recent survey becomes available through the GIS database, the City should update the rim elevations in the hydraulic model.

The subsidence impact on pipe invert elevation and pipe slope was not evaluated for the purpose of the Sewer Master Plan.

Flow splits were not verified as part of this TM. Additional surveying might be required should the flow splits not be accurately characterized in the model.

Table 1: Rim Elevation Inaccuracies

	Manhole #[a] (SY–Name)	Manhole #[b] (G-ID)	Sheet #[c]	Location	Rim elevation (Hydra, ft)	Rim elevation[d] (Survey, ft)	Comments from City	Correction Required
1	40-1-06	724	S40	Wellington Dr	33.42	N/A	Typo in rim elevation (should be 133.42 ft)	Correct typo in model
2	40-4-03	728	S40	London Dr	23.32	N/A	Typo in rim elevation (should be 123.42 ft)	Correct typo in model
3	68-1-09	1219	S38	Edsel Dr Near Roswell Dr	65.62	N/A	Typo in rim elevation (should be 165.62 ft)	Correct typo in model

Notes:
1. N/A: Not Available

Footnotes:
a. Refers to the City of Milpitas Sewer System Nodal Map, which uses the same numbering system than Hydra (SY-Name).
b. Corresponds to the unique identification number in Hydra for the entity selected.
c. Refers to Sewer System 1"=100' Maps provided by the City of Milpitas.
d. Refers to the rim elevation survey, done by aerial photograph. Data are not available at this time.

Table 2: Pipe Invert Elevation Inaccuracies

	Pipeline #[a] (SY–Name)	Pipe #[b] (G-ID)	Sheet #[c]	Location	Pipe size (Inches)	Invert Elevation In/Out (Hydra, ft)	Invert Elevation In/Out (Sewer Map, ft)	Comments from City	Correction Required
1	18-1-08	1853	S18	Intersection of Marylin Dr and Health Dr	27	-1.77/-2.77	-2.77/-2.77	As-built shows -1.77/-2.77	None
2	21-6-02	416	S21	Great Mall Parkway	15	16.24/14.94	15.69/14.94	Manhole #21-6-02 does not exist on the sewer map. Pipes #21-6-02 and 21-6-03 should be only one pipe.	Delete manhole #21-6-02. Delete pipe #21-6-02 in Hydra. Modify pipe #21-6-03 as follows: Replace upstream invert elevation in Hydra with invert elevation on sewer map; and, Update length of pipe and upstream manhole #.
3	21-6-03	421			15	15.69/16.59			

	Pipeline #[a] (SY–Name)	Pipe #[b] (G-ID)	Sheet #[c]	Location	Pipe size (Inches)	Invert Elevation In/Out (Hydra, ft)	Invert Elevation In/Out (Sewer Map, ft)	Comments from City	Correction Required
4	22-3-01	325	S22	Intersection of Moonlight Way and Capitol Av	10	14.29/11.67	14.29/11.67	As-built shows 12.29/11.67	Update upstream invert elevation in Hydra based on as-built
5	23-5-02	642	S23	Buckeye Dr	8	18.62/11.96	18.62/16.72	Sewer map is correct	Replace downstream invert elevation in Hydra with invert elevation on sewer map
6	27-5-05	32	S27	Dixon Rd	8	71.15/60.6	71.15/67.9	Sewer map is correct	Replace downstream invert elevation in Hydra with invert elevation on sewer map
7	27-5-07	37	S27	Dixon Rd	8	67.9/57.47	60.6/57.47	As-built shows 60.6/58.47	Update invert elevation in Hydra based on as-built
8	29-4-10	1753	S29 S30	N. Main St	42	-7.22/-7.26	-4.40/-7.26	As-built shows -7.24/-7.44	Update invert elevation in Hydra based on as-built.
9	30-1-04	1525	S29 S30	N. Main St	39	-6.77/7.49	-4.40/7.49	As-built shows -6.77/-7.24	Update invert elevation in Hydra based on as-built.
10	33-4-01	1319	S33	Intersection of Abel St and Serra Way	18	7.96/5.16	5.53/5.16	Sewer map is correct	Replace upstream invert elevation in Hydra with invert elevation on sewer map
11	34-4-01	1333	S34	City of SF RW	15	10.60/6.96	10.60/9.18	Sewer map is correct	Replace downstream invert elevation in Hydra with invert elevation on sewer map
12	47-4-03	940	S47	W. Pacific Railroad	15	30.03/19.10	20.03/19.10	Sewer map is correct	Replace upstream invert elevation in Hydra with invert elevation on sewer map

	Pipeline #[a] (SY–Name)	Pipe #[b] (G-ID)	Sheet #[c]	Location	Pipe size (Inches)	Invert Elevation In/Out (Hydra, ft)	Invert Elevation In/Out (Sewer Map, ft)	Comments from City	Correction Required
13	56-4-11	164	S57	Intersection of Ayer St and Park Hill Dr	8	35.36/21.17	35.36/34.89	Sewer map is correct	Replace downstream invert elevation in Hydra with invert elevation on sewer map
14	69-1-08	1572	S69	Intersection of S. Park Victoria Dr and Saratoga Dr	12	79.99/69.33	71.99/69.33	Sewer map is correct	Replace upstream invert elevation in Hydra with invert elevation on sewer map

Footnotes:
a. Refers to the City of Milpitas Sewer System Nodal Map, which uses the same numbering system than Hydra (SY-Name).
b. Corresponds to the unique identification number in Hydra for the entity selected.
c. Refers to Sewer System 1"=100' Maps provided by the City of Milpitas.

Table 3: Pipe Size Inaccuracies

	Pipe #[a] (SY–Name)	Pipe #[b] (G-ID)	Sheet #[c]	Location	Pipe size (Hydra, inches)	Pipe size (Sewer Map, inches)	Comments from City	Correction Required
1	07-3-02	1799	S7	McCarthy Blvd	36	48	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
2	08-2-01	1811	S8	McCarthy Blvd.	8	36	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
3	08-2-02	1813	S8	McCarthy Blvd	8	36		
4	08-5-01	1815	S8	McCarthy Blvd	8	36		
5	08-5-02	1817	S8	McCarthy Blvd	8	36		
6	08-5-03	1819	S8	McCarthy Blvd	8	36		
7	09-5-02	1611	S10	Technology Dr	12	10	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
8	09-3-08	1449	S9	Cypress Dr	33	36	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
9	09-3-09	1441	S9	Cypress Dr	33	36		
10	09-6-02	1439	S9	Cypress Dr	33	36		

	Pipe #[a] (SY–Name)	Pipe #[b] (G-ID)	Sheet #[c]	Location	Pipe size (Hydra, inches)	Pipe size (Sewer Map, inches)	Comments from City	Correction Required
11	09-6-04	1428	S9	Cypress Dr	30	36		
12	09-6-07	1426	S9	McCarthy Blvd	21	24	Sewer map is correct (no 21-inch section)	Replace pipe size in Hydra with pipe size on sewer map
13	10-3-01	1432	S9 S10	McCarthy Blvd	21	24/21		
14	14-6-05	1497	S14 S15	End of Milpitas Blvd and beginning of N. Main St	10	12	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
15	15-2-03	1620	S15	Jurgens Dr	24	15	24-inch line recently installed	No correction in Hydra
16	15-5-05	1517	S15	Milmont Dr	66	42	Sewer line was upsized to 66-inch by developer	No correction in Hydra
17	17-4-06	475	S17	Near Elm Av	8	10	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
18	18-6-06	596	S18	Casper St	8	10	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
19	18-6-12	598	S18	Casper St	8	10		
20	19-3-04	600	S18	Casper St	8	10		
21	19-3-07	602	S19	Casper St	8	10		
22	20-4-05DIV	1663	S20	Bellew Dr	27	30	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
23	28-6-01DIV	1669	S28	Roger St	8	6	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
24	30-2-11	502	S30	Intersection of N. Milpitas Blvd and Jacklin Rd	25	39	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
25	31-6-06	1049	S31	Intersection of N. Milpitas Blvd and Berryessa Creek	21	24	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map

	Pipe #[a] (SY–Name)	Pipe #[b] (G-ID)	Sheet #[c]	Location	Pipe size (Hydra, inches)	Pipe size (Sewer Map, inches)	Comments from City	Correction Required
26	32-6-05DIV	1672	S32	Intersection of Milpitas Blvd and Calaveras Blvd	18	15	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
27	32-1-03	1691	S32	Weller Ln	27	30	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
28	32-4-03	1740	S32	Weller Ln	27	30		
29	32-4-02	532	S32	Weller Ln	27	30		
30	33-4-05	1323	S33	Abel St	18	15	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
31	36-1-03	419	S36	Next to pumping station	8	15	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
32	36-1-05	412	S36	Next to pumping station	8	15	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
33	43-3-12	731	S43	Wool Dr	6	8	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map
34	43-6-04	733	S43	Wool Dr	6	8		
35	55-1-10	124	S43	Wool Dr	6	8		
36	43-5-16	882	S43	Jacklin Dr	24	Two 24" in parallel (siphon)	Sewer map is correct	Model parallel pipe using one pipe with "equivalent" capacity
37	44-1-17	776	S31	Angus Dr	8	10	Sewer map is correct	Replace pipe size in Hydra with pipe size on sewer map

Footnotes:
a. Refers to the City of Milpitas Sewer System Nodal Map, which uses the same numbering system than Hydra (SY-Name).
b. Corresponds to the unique identification number in Hydra for the entity selected.
c. Refers to Sewer System 1"=100' Maps provided by the City of Milpitas.

Table 4: Missing Pipes

	Manhole #[a] (SY–Name)	Manhole #[b] (G-ID)	Sheet #[c]	Location	Size (Inches)	Comments from City	Correction Required
1	17-3-01	542	S16/17	Abel St	27	Pipeline missing upstream of manhole #17-3-01	Insert pipeline in Hydra based data from sewer map
			S30	Near Pacific Railroad	27		

	Manhole #[a] (SY–Name)	Manhole #[b] (G-ID)	Sheet #[c]	Location	Size (Inches)	Comments from City	Correction Required
2	21-4-01	662	S21/S22	Alder Dr7, until Tassman Rd	10	No need to model the pipeline missing upstream of manhole #21-4-01	No correction
3	29-1-07 & 15-3-02	1459 & 1457	S15/ S29	N. Main St	12	No need to model the pipe missing between manholes #29-1-07 and 15-3-02: a plug is installed on this line	No correction at this time
4	30-5-03	505	S29/S30	N. Main St	33	33-inch line runs parallel to 36-inch line	Model parallel pipe using one pipe with "equivalent" capacity
5	30-1-07	1630	S29/S30	N. Main St	33	33-inch line runs parallel to 36-inch line	Model parallel pipe using one pipe with "equivalent" capacity
6	34-2-13	1286	S33	Sinnot Ln	12	No need to model pipe missing upstream of manhole #34-2-13, unless required for future development	No correction at this time
7	43-5-02 & 43-3-13	899 & 1012	S43	Tularcitos Creek	12	Pipe missing between manholes #43-5-02 and 43-3-13	Insert pipe in Hydra based data from sewer map
8	46-1-02	836	S46	Los Cloches St	12	No need to model pipe missing upstream of manhole #46-1-02	No correction at this time
			S33/S46	Topaz St	10		
			S46	Turquoise St	10		
9	46-1-08	841	S46	Turquoise St	10	No need to model pipe missing upstream of manhole #46-1-08	No correction at this time

Footnotes:

a. Refers to the City of Milpitas Sewer System Nodal Map, which uses the same numbering system than Hydra (SY-Name).
b. Corresponds to the unique identification number in Hydra for the entity selected.
c. Refers to Sewer System 1"=100' Maps provided by the City of Milpitas.

APPENDIX E

FLOW DIVERSION FIELD INVESTIGATION AND MODELING TM

Technical Memorandum

City of Milpitas – Sewer Master Plan

Subject: Flow Diversion Field Investigation and Modeling (addendum)

Prepared For: Aparna Chatterjee

Prepared By: Helene Kubler

Date: January 2003

Reference: 051.0080

Introduction (addendum)

When developing sewer improvement project alternatives to correct identified potential capacity deficiencies, the "plug" shown on the sewer system maps on the 12-inch diameter sewer at the intersection of N. Milpitas Blvd and Washington Dr. was investigated. The field investigation showed that there was actually no plug, but a flow diversion. The flow diversion was added to the flow diversion inventory (see **Table 1**).

Table 1: Flow Diversion Inventory (addendum)

	Manhole #[a] (SY–Name)	Manhole #[b] (G-ID)	Sheet #[c]	Location	Pipe Sizes [d] (Inches)	
					In	Out
DIV11	15-3-02	1457	S15	Intersection of N. Milpitas Blvd and Washington Dr.	10	10 & 12

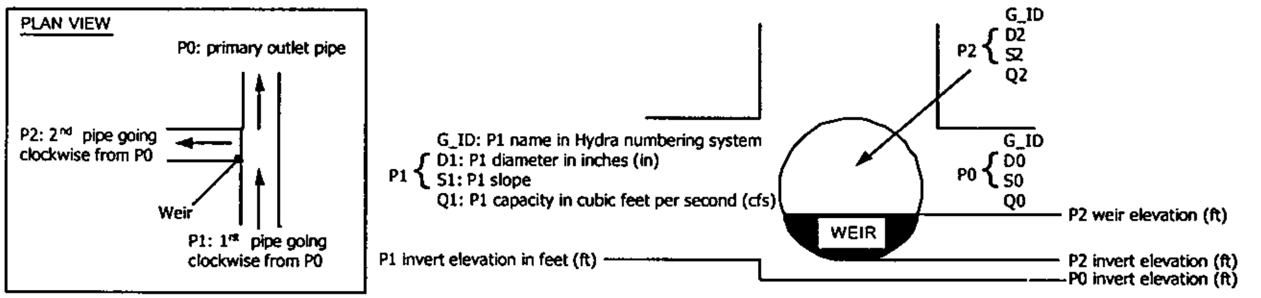
a. Refers to the City of Milpitas Sewer System Nodal Map
b. Refers to the Hydra model numbering system
c. Refers to Sewer System 1"=100' Maps provided by the City of Milpitas
d. Only the pipes that are modeled in Hydra are listed

Flow Diversion Modeling (addendum)

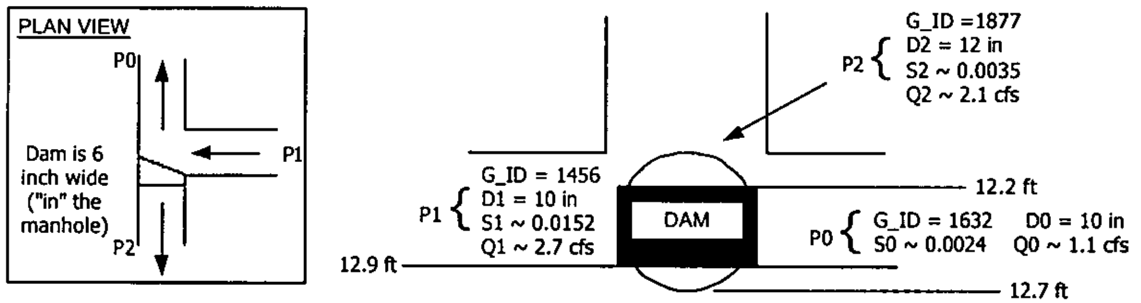
See **Table 2** (addendum)

The hydraulic model was updated to include the diversion and re-run under design conditions.

Table 2: Flow Diversion Configuration and Modeling (addendum)

<table>
<tr><th></th><th>Configuration Schematic [a,b]</th><th>Modeling & Important Field Notes [c]</th></tr>
<tr><td>Legend</td><td>
</td><td><u>HYDRA Diversion Command Input:</u>
SY_IDOVER: G_ID of overflow channel (P2)

SY_INOVER: Invert of the overflow in ft

SysQ/DivQ Sets:
Define flow diverted (DivQ) as a function of the flow entering the diversion (SysQ) in cfs.</td></tr>
<tr><td>DIV11</td><td>
</td><td><u>Assumptions:</u>
Flow diverted when P0 is approximately 75% full

<u>HYDRA Diversion Command Input:</u>
SY_IDOVER =
SY_INOVER =
SysQ/DivQ Sets:
0/0 0.8/0 3.2/2.1

<u>Operational Issues:</u>
Sediment in P2 channel behind dam (4-inch sediment)
No apparent flow in P0 channel (recirculation in manhole)
Diversion DIV11 likely not functioning properly</td></tr>
</table>

a. All hydraulic calculations are based on Manning Equation, assuming that 1) sewers are circular and 2) Manning coefficient equals to 0.013 for all pipes: $Q = (1.49/n) \times \Pi \times R^2 \times R^{2/3} \times S^{1/2}$ with Q max = pipe capacity in cfs; n = 0.013; R = radius in ft; S = slope

b. Invert elevations shown on configuration schematic are based on sewer maps provided by the City. The depth measurements taken by E2 during the field investigation were used to corroborate or supplement the sewer maps information.

c. The diversion structures in HYDRA are defined by a maximum of 30 sets of SysQ and DivQ values. The model is using a linear approximation between two sets of values.

Technical Memorandum

City of Milpitas – Sewer Master Plan

Subject:	Flow Diversion Field Investigation and Modeling
Prepared For:	Aparna Chatterjee
Prepared By:	Helene Kubler
Reviewed By:	Justine Faisst
CC:	Tom Richardson, Marilyn Nickel, Darryl Wong
Date:	September 2002 (DRAFT) December 2002 (FINAL)
Reference:	051.0080

The purpose of this Technical Memorandum (TM) is to 1) document the flow diversion field investigation conducted by E2 Consulting Engineers in August 2002, and 2) describe how the flow diversions will be modeled in HYDRA based on field data and information from the sewer system maps and record drawings provided by the City.

This TM is organized as follows:

Note: All maps can be found at the end of the TM.

References:

City of Milpitas Sewer Master Plan Update (Carollo Engineers, June 1994)
Sewer System 1"=100' Maps (City of Milpitas)

Introduction

As part of the Sewer Master Plan, RMC was tasked to update and calibrate the sewer system hydraulic model (HYDRA). During the calibration effort, significant differences between modeled and metered flows were identified that could be due to misrepresentations of the flow diversions hydraulics.

Flow diversions are currently modeled based on the 1994 Sewer Master Plan data. The 1994 master plan does not include any documentation of the field investigation that was conducted at that time, nor any detailed documentation on how the flow diversion hydraulics were estimated. In addition, existing record drawings and sewer maps do not provide all the information necessary to model the diversions.

RMC recommended that field investigation be performed for all sewer system diversions to support documentation in the Sewer Master Plan Report. Field investigation was limited to basic documentation of the diversion operation, including observation of flow direction, measurement of invert depth to ground, and pictures. No surveying was involved.

The sewer system includes ten flow diversions, as identified in Table 1. The location of the diversions is shown on Map 1.

Table 1: Flow Diversion Inventory

	Manhole #[a] (SY–Name)	Manhole #[b] (G-ID)	Sheet #[c]	Location	Pipe Sizes [d] (Inches)	
					In	Out
DIV01	28-6-01	716	S28	Intersection of Curtner Dr and Roger St.	8	8 & 6
DIV02	43-3-14	1856	S43	Hillview Dr. between Del Vaile and Del Rio Ct.	12	12 & 12
DIV03	31-2-04	523	S31	North Milpitas Blvd. at Hidden Lake Park	30	24 & 30
DIV04	57-1-07	202	S57	East Calaveras Blvd. between Highway 680 and Dempsey Wy.	12 & 21	15 & 21
DIV05	32-6-05	779	S32	Intersection of East Calaveras Blvd. and Milpitas Blvd.	15 & 18	15 & 18
DIV06	57-5-12	213	S57	Dempsey Rd. betweem Shirley and Edsel Dr.	21	12 & 21
DIV07	20-4-05	1407	S20	Intersection of Barber Ln. and Bellew Dr.	27 & 30	27 & 30
DIV08	34-2-13	1287	S34	Main St. – North of Hetch Hetchy Aqueduct easement	18	18 & 24
DIV09	34-4-01	1334	S34	Abel St. – North of Hetch Hetchy Aqueduct easement	15 & 24	15 & 30
DIV10	20-6-03	1370	S20	Ditch West of Elmwood Jail – North of Hetch Hetchy Aqueduct easement	15	15 & 15

a. Refers to the City of Milpitas Sewer System Nodal Map
b. Refers to the Hydra model numbering system
c. Refers to Sewer System 1"=100' Maps provided by the City of Milpitas
d. Only the pipes that are modeled in Hydra are listed

Flow Diversion Field Investigation

E2 Consulting Engineers performed the field investigations in August 2002. All the work was performed without going down into the manhole, but by using a camera attached to a pole. E2's Diversion Structure Investigation Report, including sanitary structure observation forms and pictures, is attached to this TM.

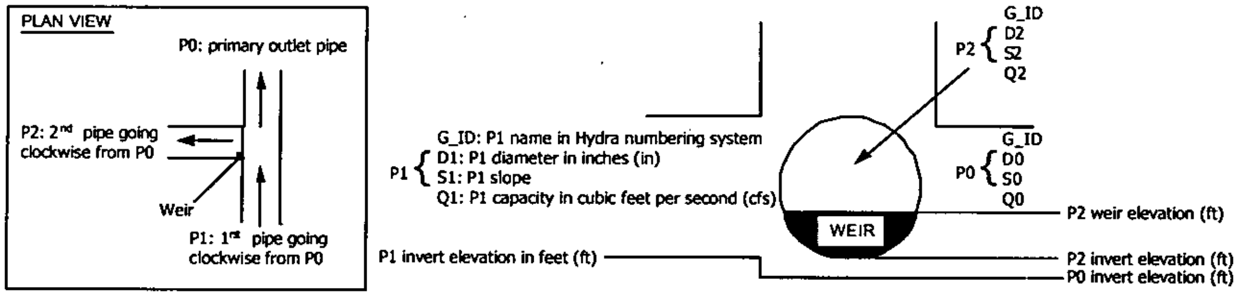
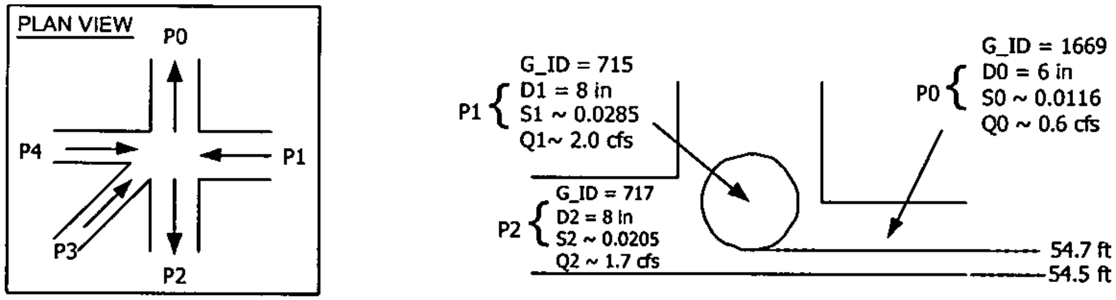
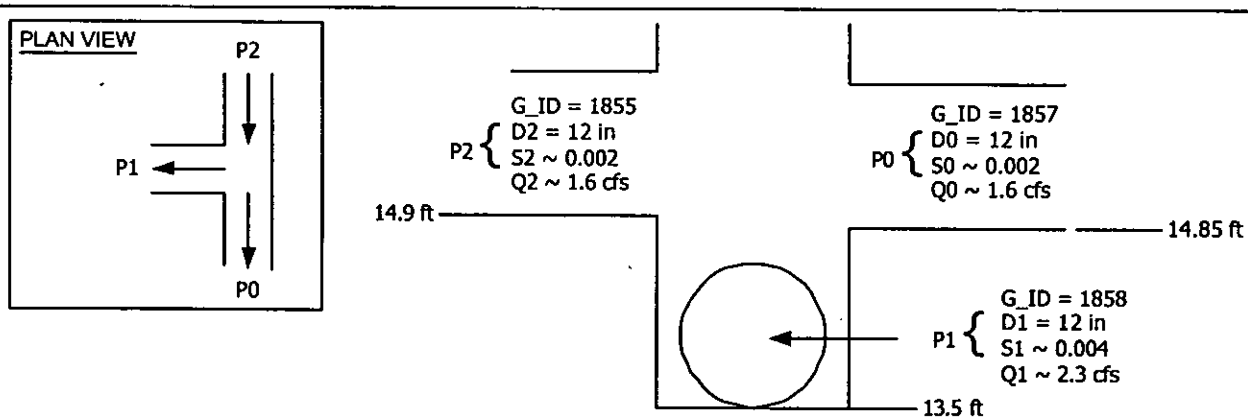
Flow Diversion Modeling

The hydraulics of each flow diversion was examined based on the field data documented in E2's Diversion Structure Investigation Report and information on manhole configuration, and pipe invert and slope available from the sewer system maps and record drawings provided by the City.

The Manning equation was used to evaluate the flow diversion hydraulics and determine the input into HYDRA's flow diversion command. The diversion structures in HYDRA are defined by a maximum of 30 sets of values, each set defining the flow entering the diversion structure (SysQ) and flow that is diverted (DivQ). The computer model is using a linear approximation between two sets of values.

Table 2 presents schematically the configuration of each diversion and gives the sets of SysQ and DivQ values (in cubic feet per second) that will be used in HYDRA to model the diversion. The appropriateness of these sets of values will be verified when calibrating the computer model based on downstream wet weather flow monitoring data.

Table 2: Flow Diversion Configuration and Modeling

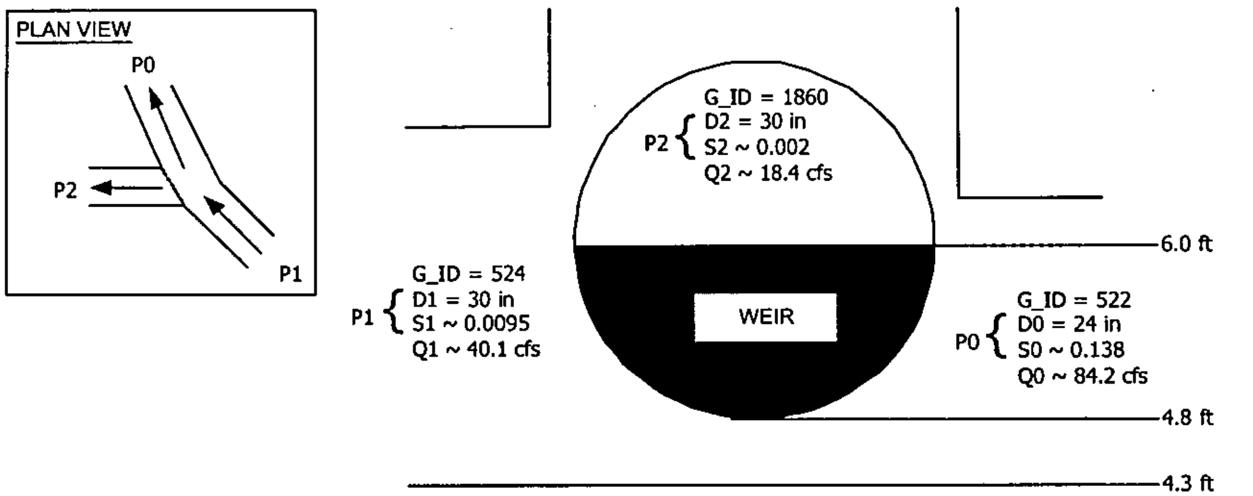
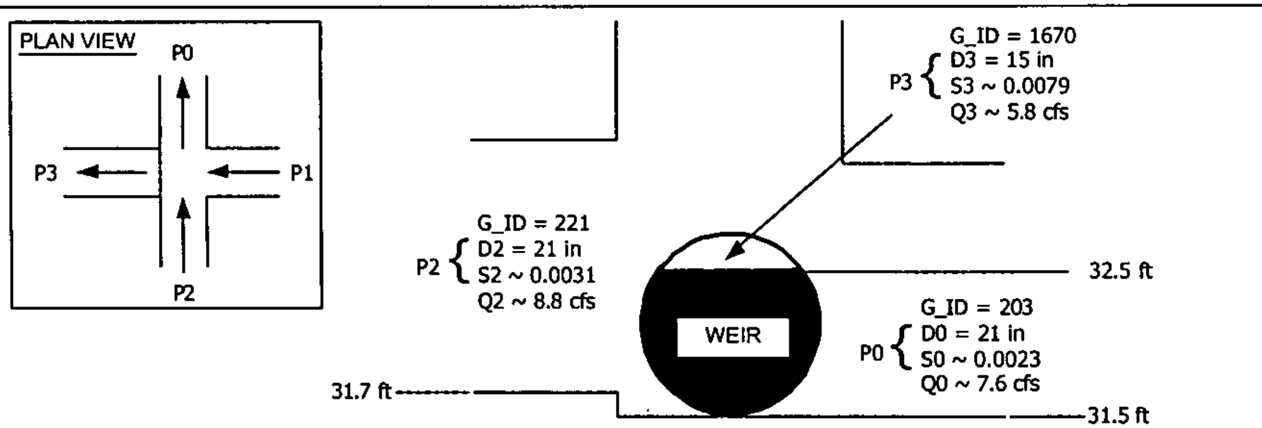
	Configuration Schematic [a,b]	Modeling & Important Field Notes [c]
Legend		<u>HYDRA Diversion Command Input:</u> SY_IDOVER: G_ID of overflow channel (P2) SY_INOVER: Invert of the overflow in ft SysQ/DivQ Sets: Define flow diverted (DivQ) as a function of the flow entering the diversion (SysQ) in cfs.
DIV01		<u>Assumptions:</u> Flow split is proportional to Q0 to Q2 ratio until P0 is full <u>HYDRA Diversion Command Input:</u> SY_IDOVER = 717 SY_INOVER = 54.5 SysQ/DivQ Sets: 0/0 2.3/1.7 2.31/1.71 10.0/9.4
DIV02		<u>Assumptions:</u> Flow diverted when P1 is full <u>HYDRA Diversion Command Input:</u> SY_IDOVER = 1857 SY_INOVER = 14.85 SysQ/DivQ Sets: 0/0 2.3/0 2.31/0.01 10.0/7.7 <u>Operational Issues:</u> Very heavy sediment blocking P1 channel. **Diversion DIV02 is not functioning.** Since this is apparently not a temporary situation, the diversion should be modeled as not functioning (SysQ/DivQ Sets: 0/0 10.0/10.0)

a. All hydraulic calculations are based on Manning Equation, assuming that 1) sewers are circular and 2) Manning coefficient equals to 0.013 for all pipes: $Q = (1.49/n)\times\Pi\times R^2\times R^{2/3}\times S^{1/2}$ with Q max = pipe capacity in cfs; n = 0.013; R = radius in ft; S = slope

b. Invert elevations shown on configuration schematic are based on sewer maps provided by the City. The depth measurements taken by E2 during the field investigation were used to corroborate or supplement the sewer maps information.

c. The diversion structures in HYDRA are defined by a maximum of 30 sets of SysQ and DivQ values. The model is using a linear approximation between two sets of values.

Table 2: Flow Diversion Configuration and Modeling (continued)

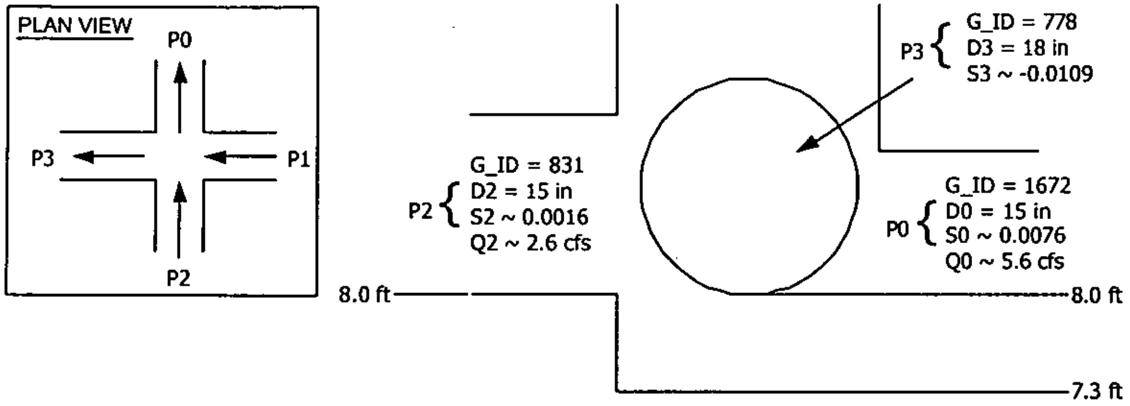
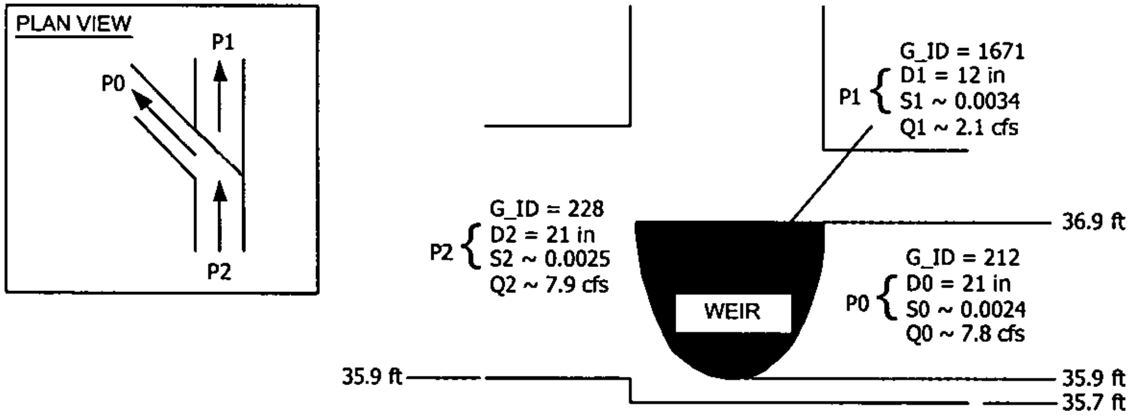
	Configuration Schematic [a,b]	Modeling & Important Field Notes [c]
DIV03		Assumptions: Flow diverted when P0 is 85% full Since Q1 ~ 40 cfs, the flow diversion will never be activated HYDRA Diversion Command Input: SY_IDOVER = 1860 SY_INOVER = 6.0 SysQ/DivQ Sets: 0/0 50.0/0
DIV04		Assumptions: Flow diverted when P0 is approximately 60% full HYDRA Diversion Command Input: SY_IDOVER = 1670 SY_INOVER = 32.5 SysQ/DivQ Sets: 0/0 5.6/0 5.61/0.01 13.4/5.8 20.0/5.8

a. All hydraulic calculations are based on Manning Equation, assuming that 1) sewers are circular and 2) Manning coefficient equals to 0.013 for all pipes:
$Q = (1.49/n) \times \Pi \times R^2 \times R^{2/3} \times S^{1/2}$ with Q max = pipe capacity in cfs; n = 0.013; R = radius in ft; S = slope

b. Invert elevations shown on configuration schematic are based on sewer maps provided by the City. The depth measurements taken by E2 during the field investigation were used to corroborate or supplement the sewer maps information.

c. The diversion structures in HYDRA are defined by a maximum of 30 sets of SysQ and DivQ values. The model is using a linear approximation between two sets of values.

Table 2: Flow Diversion Configuration and Modeling (continued)

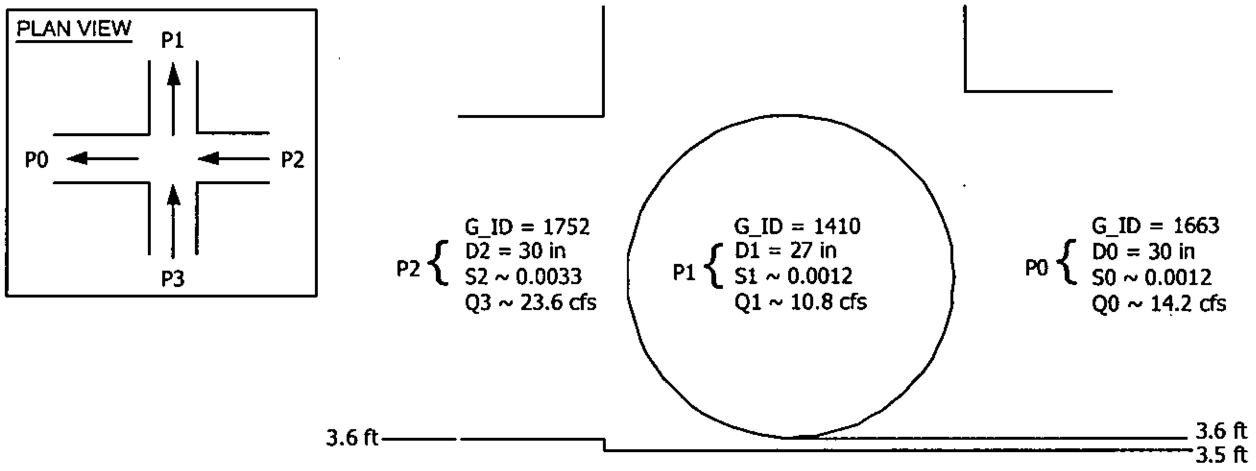
	Configuration Schematic [a,b]	Modeling & Important Field Notes [c]
DIV05		<u>Assumptions:</u> Flow diverted when P0 is full. Negative slope in P3 is "real". P3 acts like a dam. Top of dam (i.e. invert of P3 outlet) has an elevation of 8.74 ft. <u>HYDRA Diversion Command Input:</u> SY_IDOVER = 778 SY_INOVER = 8.74 SysQ/DivQ Sets: 0/0 5.6/0 5.61/0.01 10.0/4.4
DIV06		<u>Assumptions:</u> Flow diverted when P0 is approximately 70% full <u>HYDRA Diversion Command Input:</u> SY_IDOVER = 1671 SysQ/DivQ Sets: 0/0 5.5/0 5.51/0.01 9.9/2.1 15.0/2.1 <u>Operational Issues:</u> Heavy sediment in P1 channel (bricks, mortar)

a. All hydraulic calculations are based on Manning Equation, assuming that 1) sewers are circular and 2) Manning coefficient equals to 0.013 for all pipes: $Q = (1.49/n) \times \Pi \times R^2 \times R^{2/3} \times S^{1/2}$ with Q max = pipe capacity in cfs; n = 0.013; R = radius in ft; S = slope

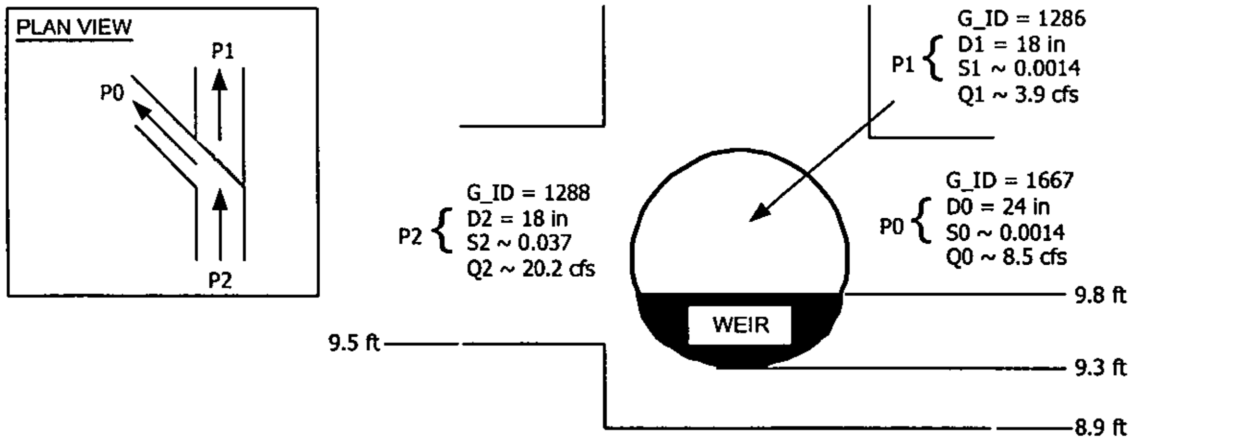
b. Invert elevations shown on configuration schematic are based on sewer maps provided by the City. The depth measurements taken by E2 during the field investigation were used to corroborate or supplement the sewer maps information.

c. The diversion structures in HYDRA are defined by a maximum of 30 sets of SysQ and DivQ values. The model is using a linear approximation between two sets of values.

Table 2: Flow Diversion Configuration and Modeling (continued)

<table>
<tr><th></th><th>Configuration Schematic [a,b]</th><th>Modeling & Important Field Notes [c]</th></tr>
<tr><td>DIV07</td><td>
</td><td><u>Assumptions:</u>
Flow split is proportionally to Q1 to Q0 ratio

<u>HYDRA Diversion Command Input:</u>
SY_IDOVER = 1410
SY_INOVER = 3.6
SysQ/DivQ Sets:
0/0 25.0/10.8

<u>Operational Issues:</u>
Sediment in P1 channel</td></tr>
<tr><td>DIV08</td><td>
</td><td><u>Assumptions:</u>
Flow diverted when P0 is approximately 45% full

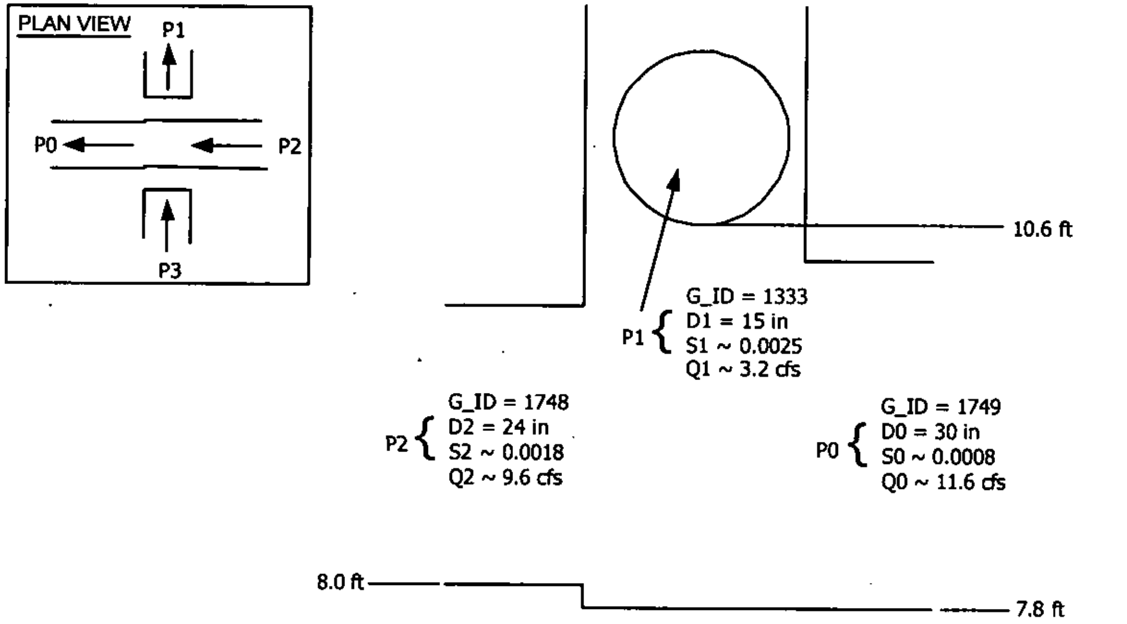
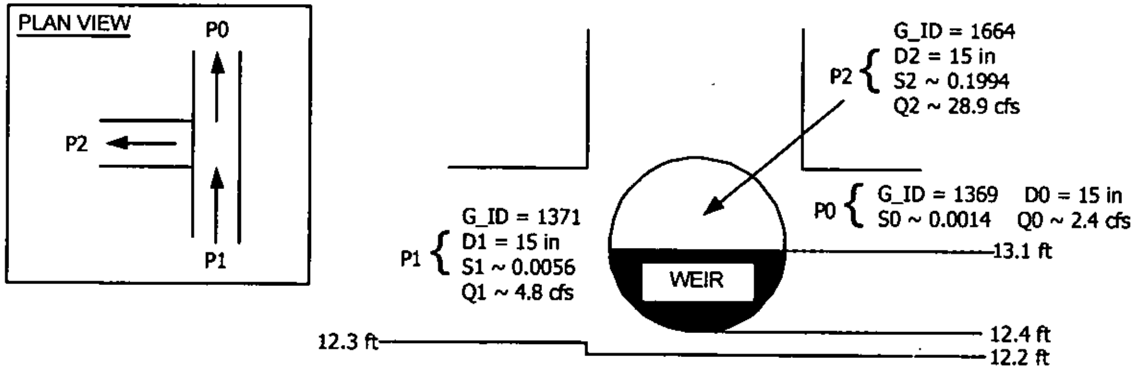
<u>HYDRA Diversion Command Input:</u>
SY_IDOVER = 1286
SY_INOVER = 9.8
SysQ/DivQ Sets:
0/0 3.8/0 3.81/0.01 12.4/3.9 20.2/3.9</td></tr>
</table>

a. All hydraulic calculations are based on Manning Equation, assuming that 1) sewers are circular and 2) Manning coefficient equals to 0.013 for all pipes: $Q = (1.49/n) \times \pi \times R^2 \times R^{2/3} \times S^{1/2}$ with Q max = pipe capacity in cfs; n = 0.013; R = radius in ft; S = slope

b. Invert elevations shown on configuration schematic are based on sewer maps provided by the City. The depth measurements taken by E2 during the field investigation were used to corroborate or supplement the sewer maps information.

c. The diversion structures in HYDRA are defined by a maximum of 30 sets of SysQ and DivQ values. The model is using a linear approximation between two sets of values.

Table 2: Flow Diversion Configuration and Modeling (continued)

	Configuration Schematic [a,b]	Modeling & Important Field Notes [c]
DIV09		Assumptions: Flow diverted when P0 is full HYDRA Diversion Command Input: SY_IDOVER = 1333 SY_INOVER = 10.6 SysQ/DivQ Sets: 0/0 11.6/0 11.61/0.01 20.0/3.2
DIV10		Assumptions: Flow diverted when P0 is approximately 70% full HYDRA Diversion Command Input: SY_IDOVER = 1664 SY_INOVER = 13.1 SysQ/DivQ Sets: 0/0 1.7/0 1.71/0.01 5.0/3.6

a. All hydraulic calculations are based on Manning Equation, assuming that 1) sewers are circular and 2) Manning coefficient equals to 0.013 for all pipes:
$Q = (1.49/n)\times\Pi\times R^2\times R^{2/3}\times S^{1/2}$ with Q max = pipe capacity in cfs; n = 0.013; R = radius in ft; S = slope

b. Invert elevations shown on configuration schematic are based on sewer maps provided by the City. The depth measurements taken by E2 during the field investigation were used to corroborate or supplement the sewer maps information.

c. The diversion structures in HYDRA are defined by a maximum of 30 sets of SysQ and DivQ values. The model is using a linear approximation between two sets of values.

Map 1
Flow Diversions
Location

City of Milpitas
Sewer Master Plan

N

0 0.3 0.6 Miles

ATTACHMENT

Diversion Structure Investigation – August 2002

Conducted by E2 Consulting Engineers, Inc.

APPENDIX F

HYDRAULIC MODEL CALIBRATION RESULTS

HYDRA Run Reference

Folder
Calibrated 2002

Run
WD02.run
WE02.run

Base flow
PA_2001.shp transferred to PA_WD01 and PA_WE01 (Hydra)

I/I
Defects2_manh.shp linked to Defects.dbf (Hydra) using Microsoft Access

Storm
None

Collection System
SY_2002

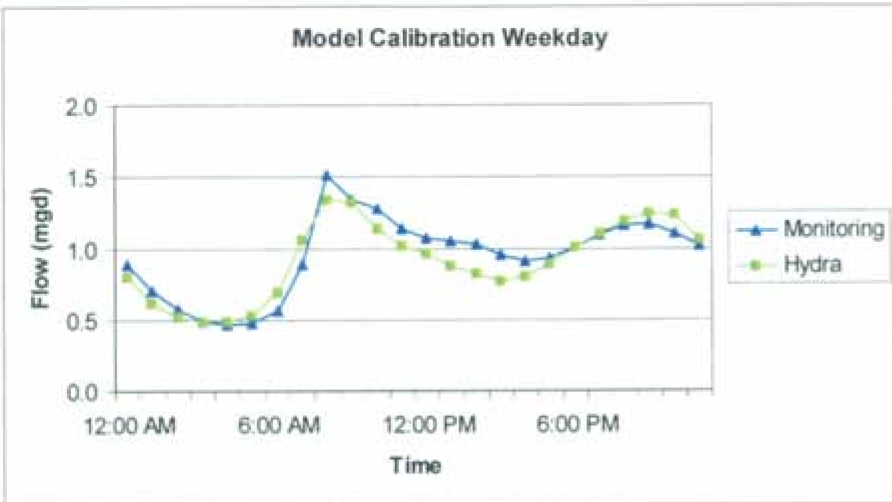
HYDRA Run Results

Figures 1 through 12 compare the modeled flow with the average flow measured at each wet weather flow monitoring site. Tables 1 through 12 compare the average and peak hour modeled flow with the average and peak hour flow measured at each wet weather flow monitoring site. Comments on the results are provided for each flow monitoring site.

The excel spreadsheet that served to generate these figures and tables is provided on a CD-Rom. It can serve for future calibration work.

SITE 1

Figure 1: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 1



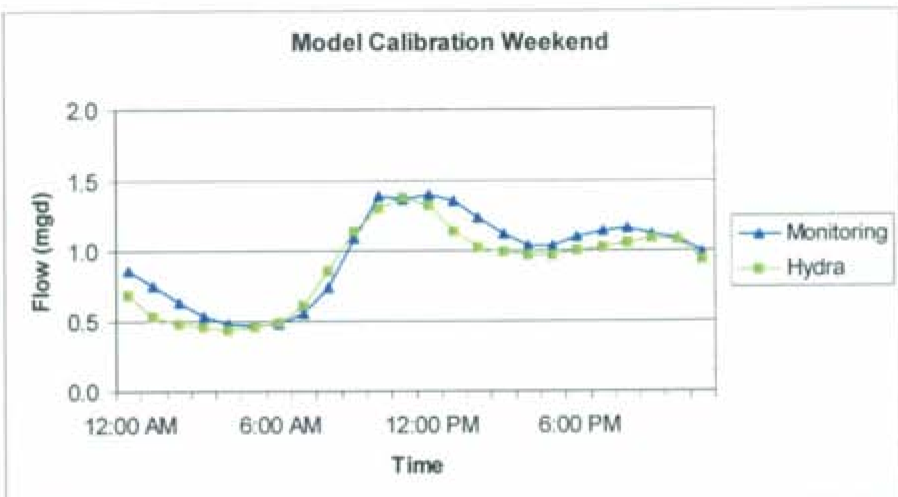


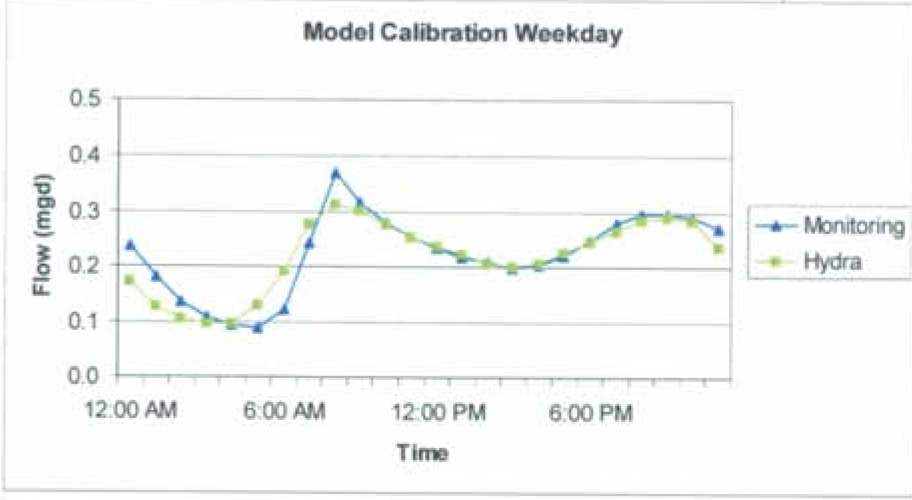
Table 1: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 1

	Peak		Average	
	mgd	%	mgd	%
Weekday	0.1722	11.4	0.0344	3.6
Weekend	0.0164	1.2	0.0708	7.4
Criteria		**20**		**10**

COMMENT: None

SITE 2

Figure 2: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 2



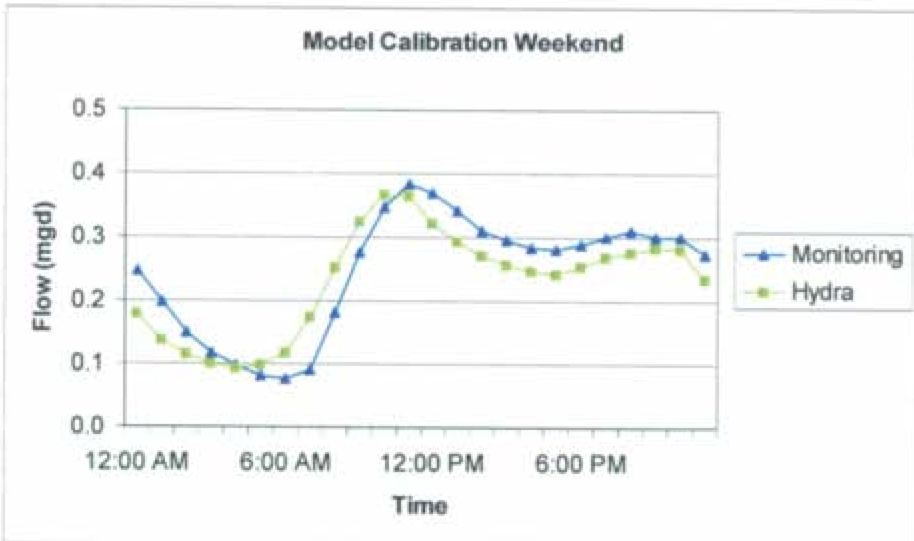


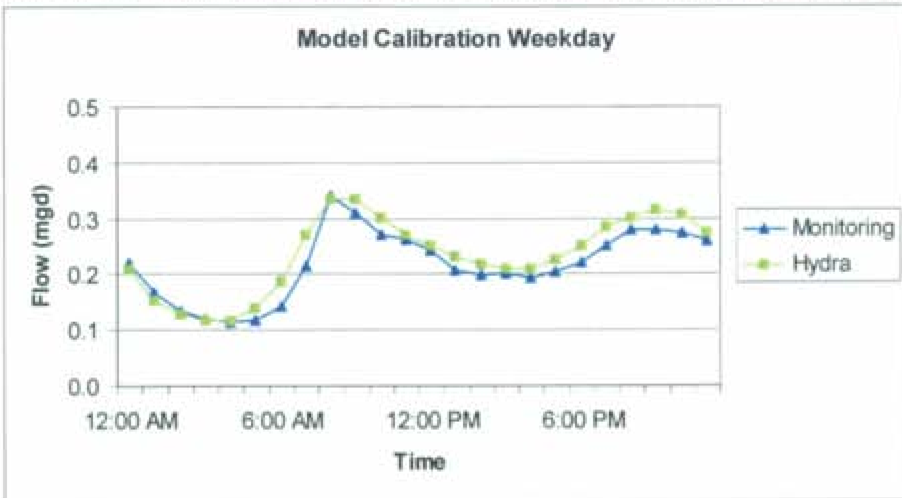
Table 2: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 2

	Peak		Average	
	mgd	%	mgd	%
Weekday	0.0558	15.2	0.0063	2.8
Weekend	0.0178	4.7	0.0144	5.9
Criteria		**20**		**10**

COMMENT: None

SITE 3

Figure 3: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 3



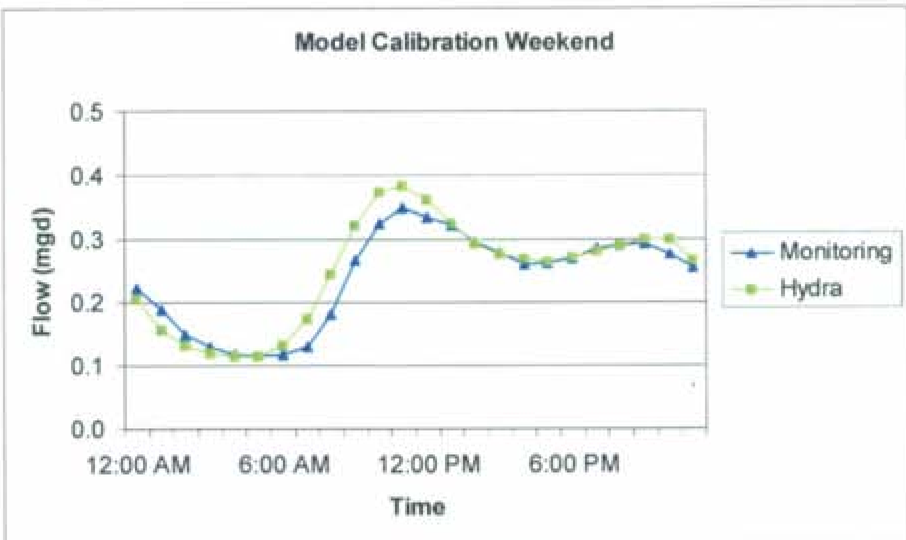


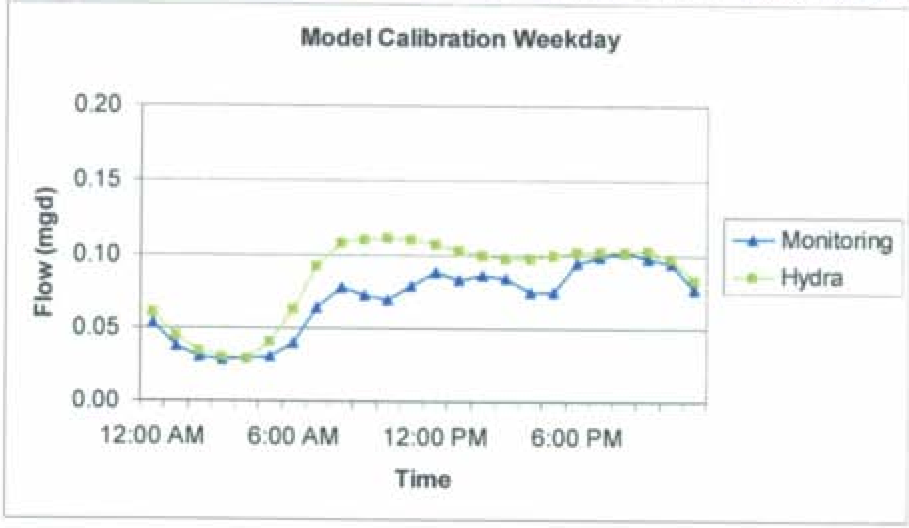
Table 3: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 3

	Peak		Average	
	mgd	%	mgd	%
Weekday	0.0054	1.6	-0.0175	8.1
Weekend	-0.0340	9.7	-0.0110	4.6
Criteria		**20**		**10**

COMMENT: None

SITE 4

Figure 4: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 4



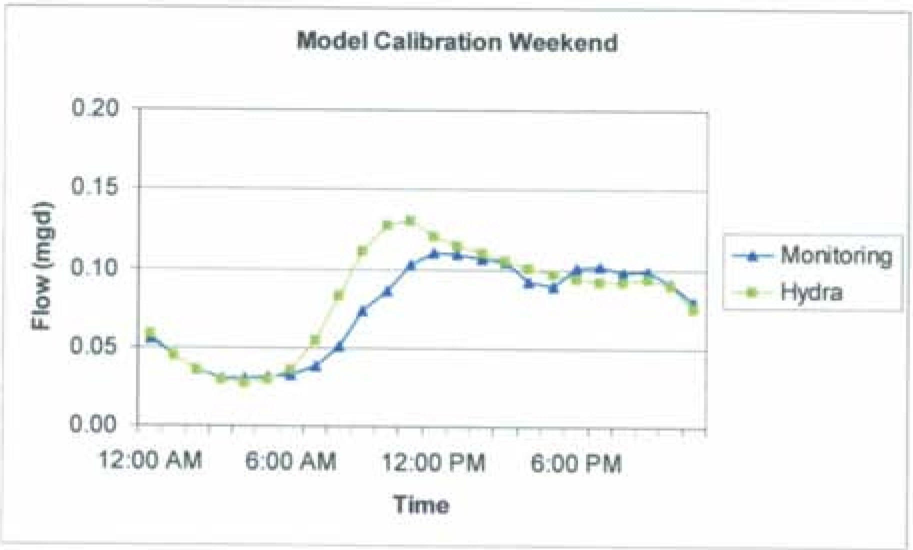


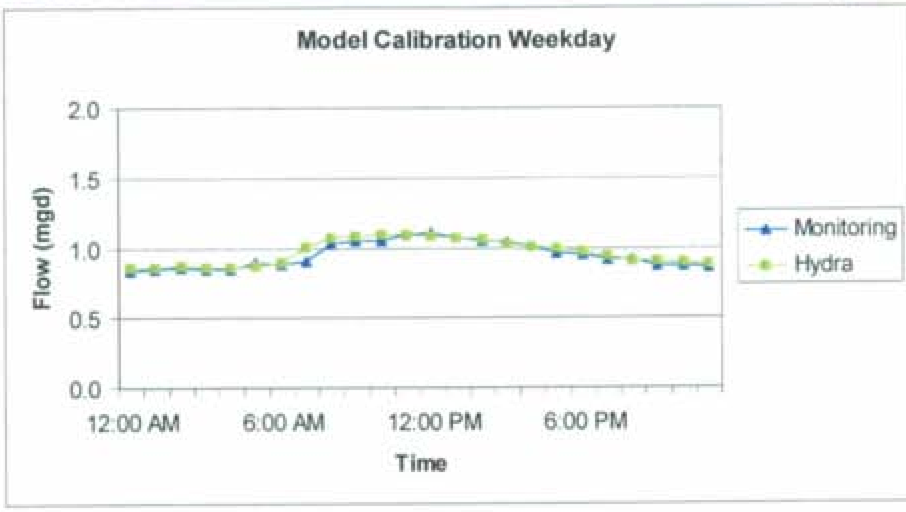
Table 4: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 4

	Peak		Average	
	mgd	%	mgd	%
Weekday	-0.0090	8.8	-0.0152	22.0
Weekend	-0.0203	18.5	-0.0068	9.1
Criteria		**20**		**10**

COMMENT: The model is showing higher flow than the average metered flow, especially during the morning peak. The model is slightly more conservative. It was decided not to try to adjust the flow factors and diurnal flow patterns for this particular area sine its contribution to the overall flow is not significant. In addition, no conveyance capacity was later identified for this area.

SITE 5

Figure 5: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 5



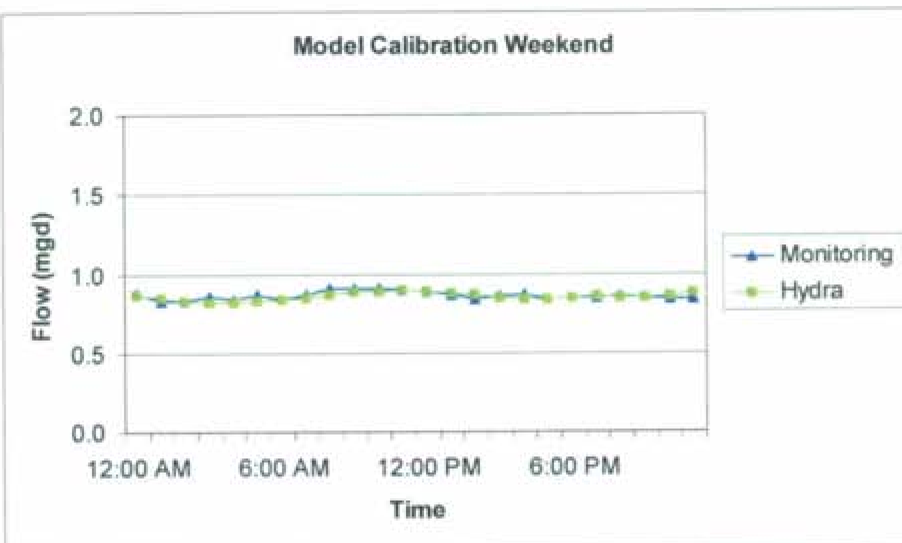


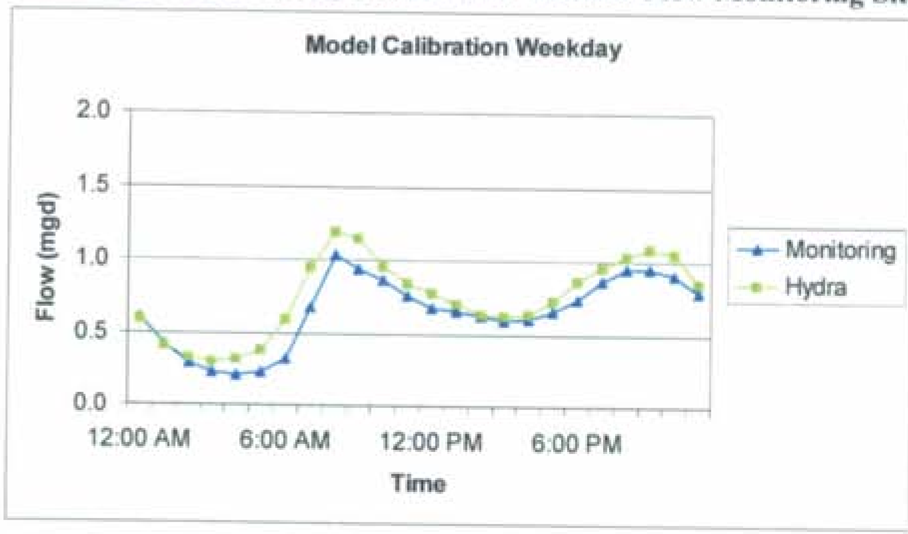
Table 5: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 5

	Peak		Average	
	mgd	%	mgd	%
Weekday	0.0178	1.6	-0.0156	1.6
Weekend	0.0138	1.5	0.0047	0.5
Criteria		**20**		**10**

COMMENT: None

SITE 6

Figure 6: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 6



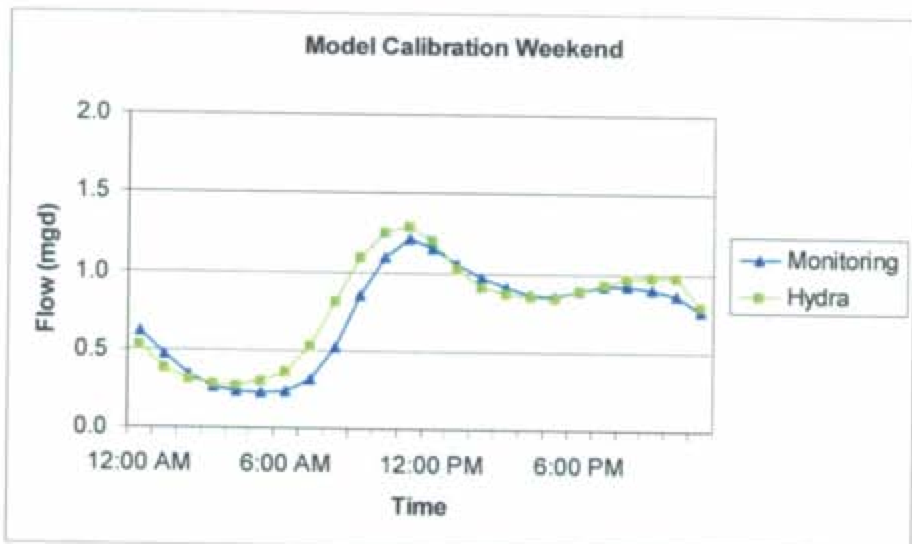


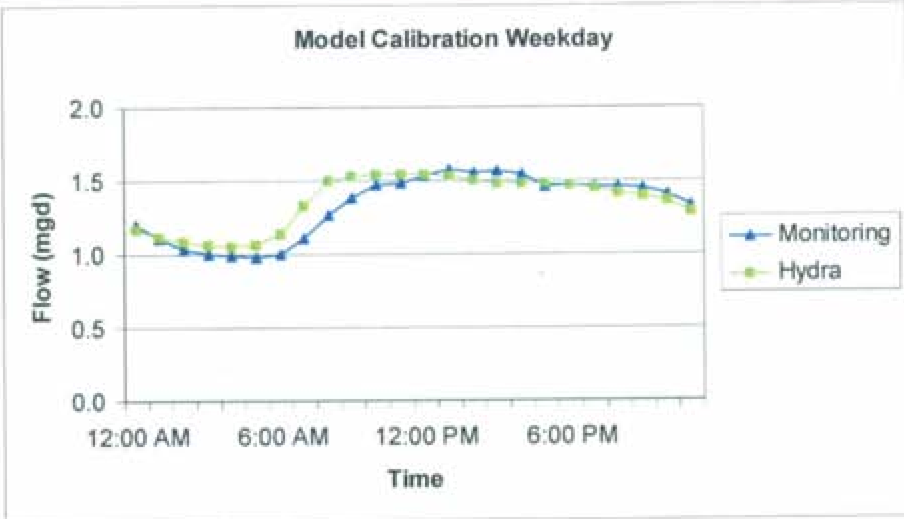
Table 6: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 6

	Peak		Average	
	mgd	%	mgd	%
Weekday	-0.1502	14.5	-0.1011	15.6
Weekend	-0.0820	6.8	-0.0504	7.0
Criteria		**20**		**10**

COMMENT: The average flow during weekday does not meet calibration criteria. However, because 1) weekend flow is calibrated, and 2) peak weekend flow larger than peak weekday flow (absolute peak flow used to determine capacity deficiencies), it is considered acceptable for the purpose of this Master Plan

SITE 7

Figure 7: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 7



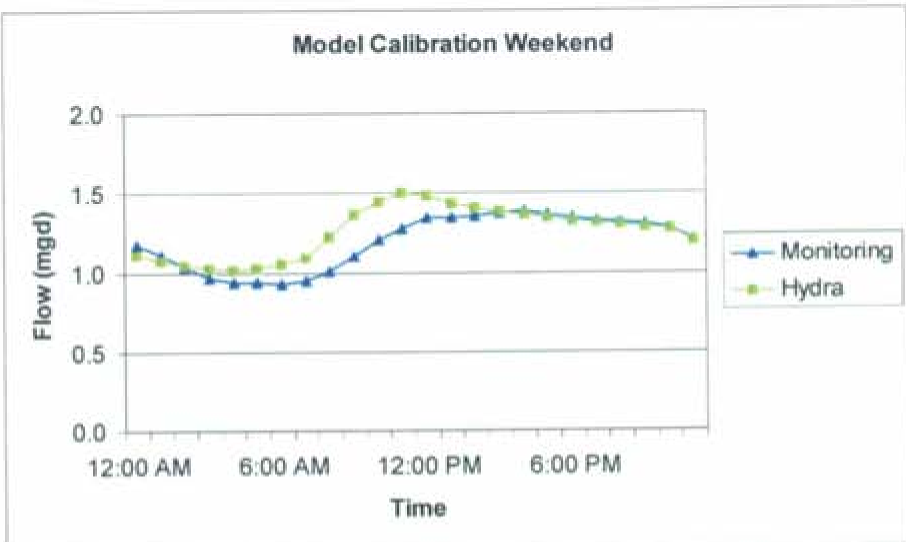


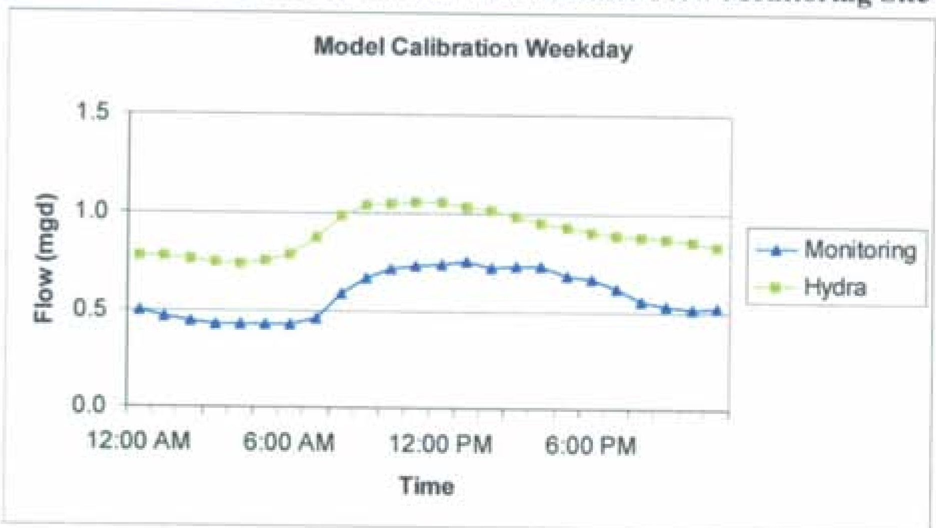
Table 7: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 7

	Peak		Average	
	mgd	%	mgd	%
Weekday	0.0298	1.9	-0.0306	2.3
Weekend	-0.1202	8.7	-0.0633	5.3
Criteria		**20**		**10**

COMMENT: None

SITE 8

Figure 8: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 8



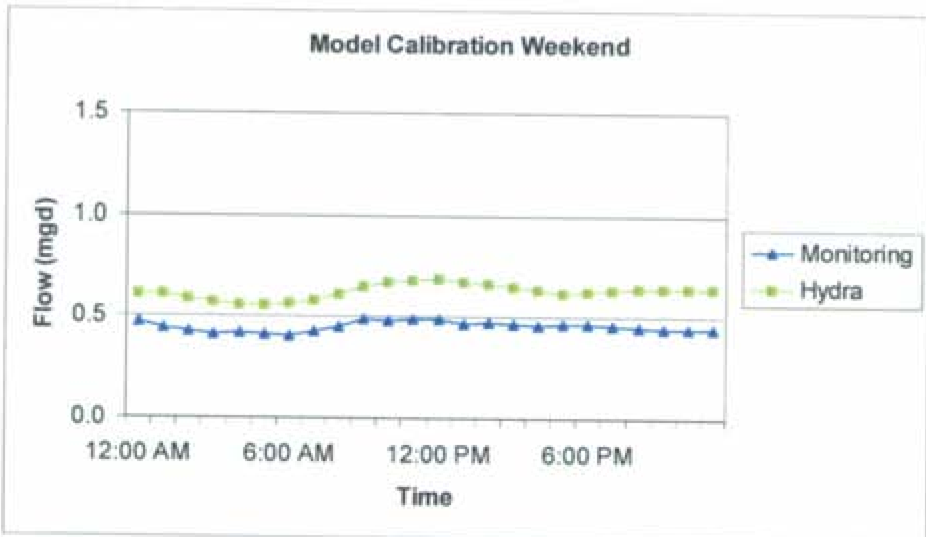


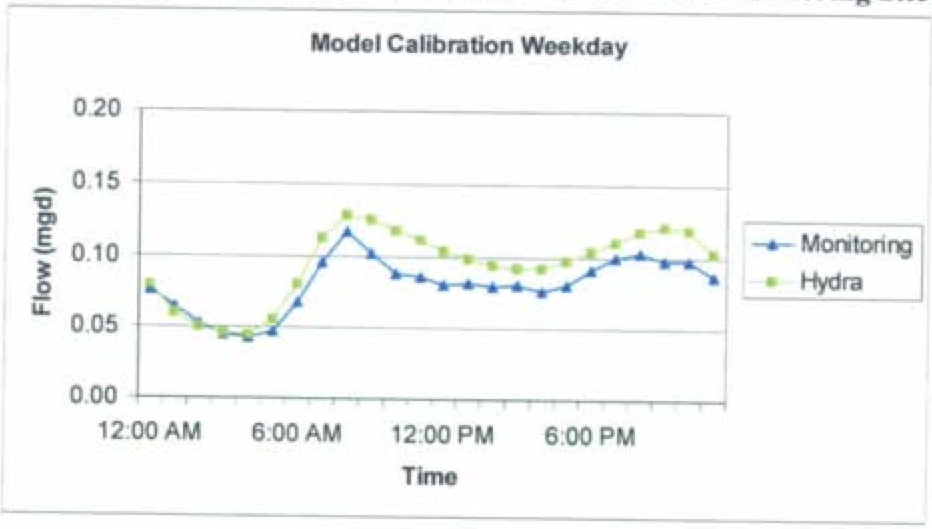
Table 8: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 8

	Peak		Average	
	mgd	%	mgd	%
Weekday	-0.3013	39.8	-0.3122	53.3
Weekend	-0.1951	39.8	-0.1726	38.3
Criteria		**20**		**10**

COMMENT: Site 8 corresponds to an industrial area that has been considerably impacted by the economic downturn, with an occupancy rate that has dropped significantly between June 2001 (period when the site was monitored to determine the unit base wastewater flow factors) and Winter 2001/2002 (period when the site was monitored to evaluate inflow and infiltration). As a result the modeled flow (assuming 100% occupancy) are higher than the flow measured during the winter 2002 flow monitoring period. This site is considered calibrated because dry weather flows are consistent with flow measured during the 2001 dry weather flow monitoring program.

SITE 9

Figure 9: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 9



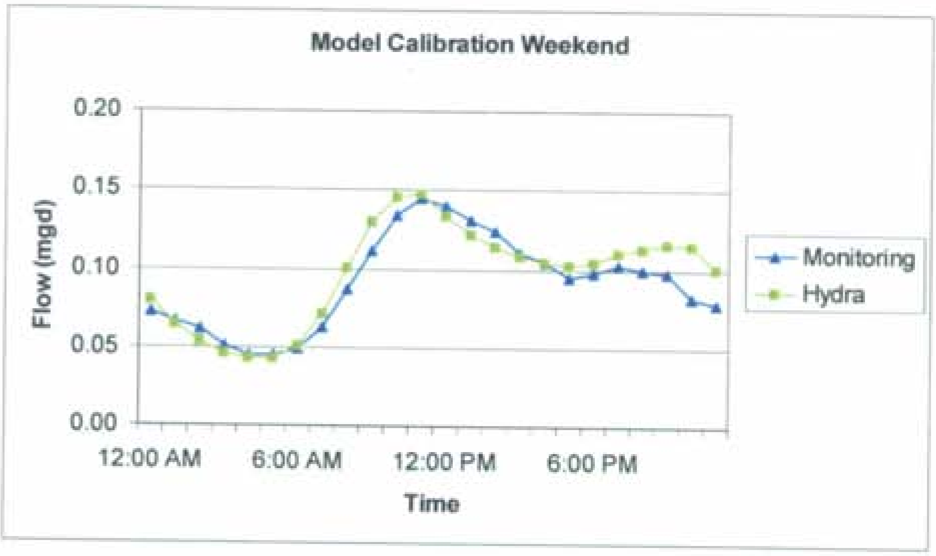


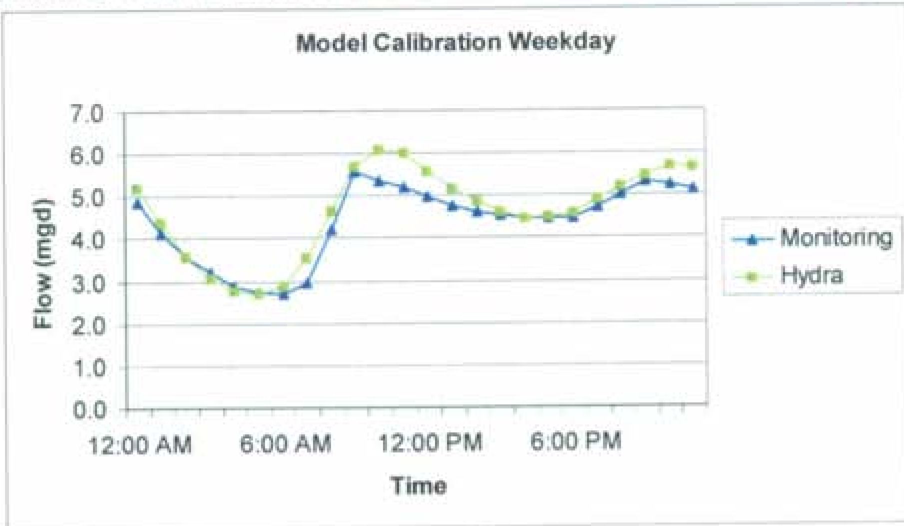
Table 9: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 9

	Peak		Average	
	mgd	%	mgd	%
Weekday	-0.0121	10.4	-0.0148	18.7
Weekend	-0.0021	1.5	-0.0044	4.8
Criteria		**20**		**10**

COMMENT: Similar to Site 6, the average flow during weekday does not meet calibration criteria. However, because 1) weekend flow is calibrated, and 2) peak weekend flow larger than peak weekday flow (absolute peak flow used to determine capacity deficiencies), it is considered acceptable for the purpose of this Master Plan.

SITE 10

Figure 10: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 10



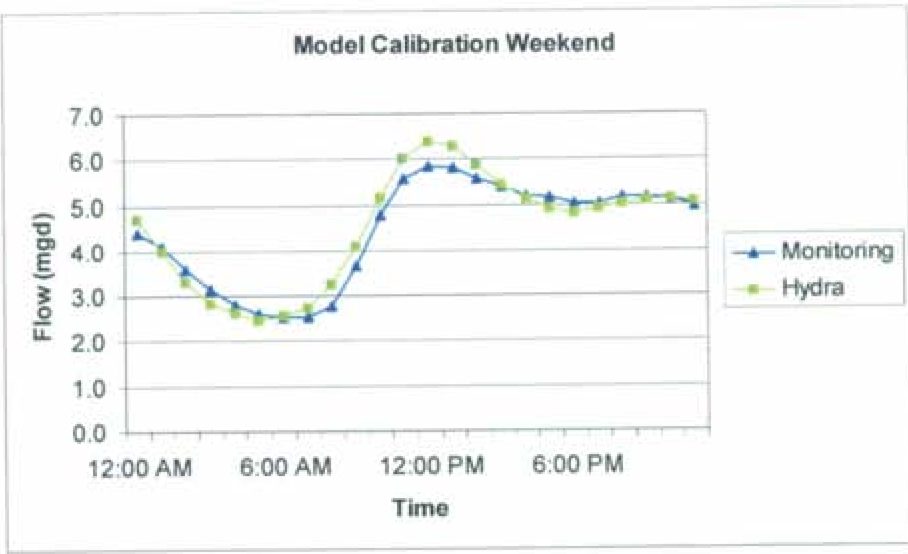


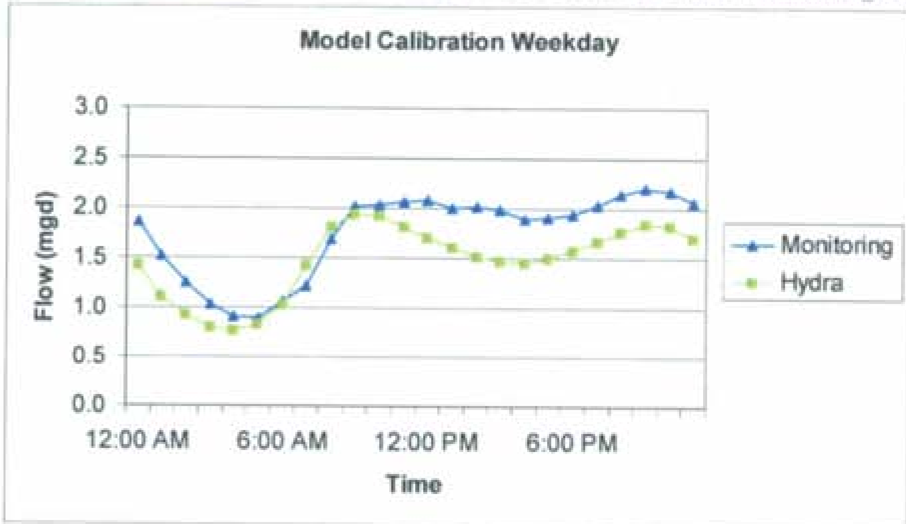
Table 10: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 10

	Peak		Average	
	mgd	%	mgd	%
Weekday	-0.5215	9.4	-0.2562	5.9
Weekend	-0.5464	9.4	-0.0851	1.9
Criteria		**20**		**10**

COMMENT: None

SITE 11

Figure 11: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 11



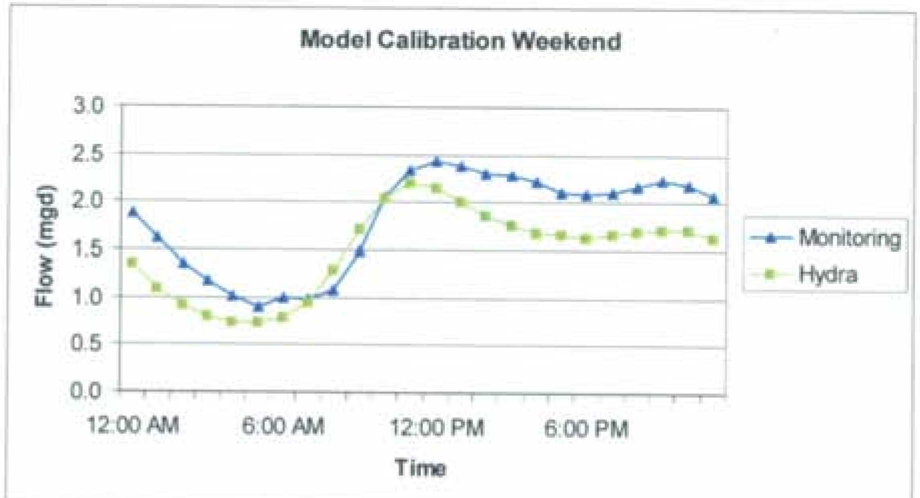


Table 11: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 11

	Peak		Average	
	mgd	%	mgd	%
Weekday	0.2677	12.2	0.2707	15.5
Weekend	0.2189	9.0	0.3190	17.6
Criteria		**20**		**10**

COMMENT: Although the modeled and measured flow patterns are relatively consistent, the average modeled flow is significantly lower than the measured flow. Several checks were performed to identify the potential issues:

- Average winter water use for the metered area (calculated using the water use records per parcel) is approximately 1.4 mgd. The total average wastewater flow should be in the range of 1.4 – 1.7 mgd (assuming that 70% - 90% of the water use and a total GWI of 0.4 mgd). The metered flow is on the high side of this range. The modeled flow is on the low side of this range. No obvious error could be identified by conducting this analysis.
- Upstream flow diversions were verified to identify other potential "sources" of wastewater. However, we have good confidence in the way flow diversions are modeled since 1) modeled characteristics for each diversion are based on field data and 2) Sites 1, 10, and 12 (the 3 other downstream calibration sites) are satisfactorily calibrated.
- Both Site 4 and Site 9 are contributing to this area (they represent approximately 10% of the flow at Site 11) and are satisfactorily calibrated. That would tend to indicate that diurnal flow patterns and unit wastewater flow factors are correct.
- Low groundwater infiltration rates were not thought to cause the discrepancy since metered and modeled minimum flows closely match.
- The meter at Site 11 was out of calibration during late flow monitoring period. However, there is relatively good confidence of the validity of the data for the rest of the period (at plus or minus 10%).

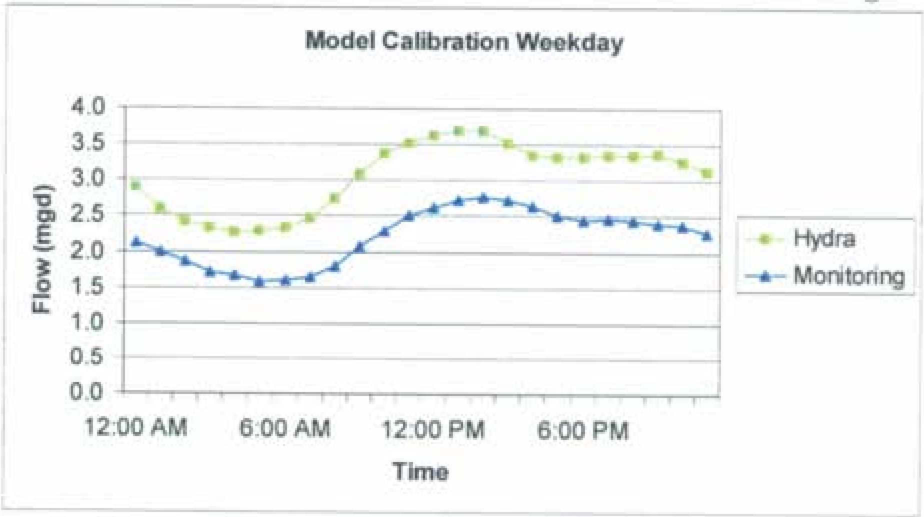
It was concluded that the discrepancy in the average monitored flow was due to a combination of low unit base wastewater flow factors and low population estimates for this area of the City.

However, because the weekday and weekend peak hour flows (used for identify capacity deficiencies) meet the calibration criteria, it was decided not to "tweak" the residential population number and/or unit base wastewater flow factors for the contributing area for the purpose of developing a planning level hydraulic model. Instead, it was verified that the pipes that were not showing capacity deficiencies under the different planning scenarios could accommodate an incremental 0.5 mgd at peak hour under storm conditions.

When collecting wet weather flow monitoring data in the future, the calibration of this site should be verified.

SITE 12

Figure 12: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 12



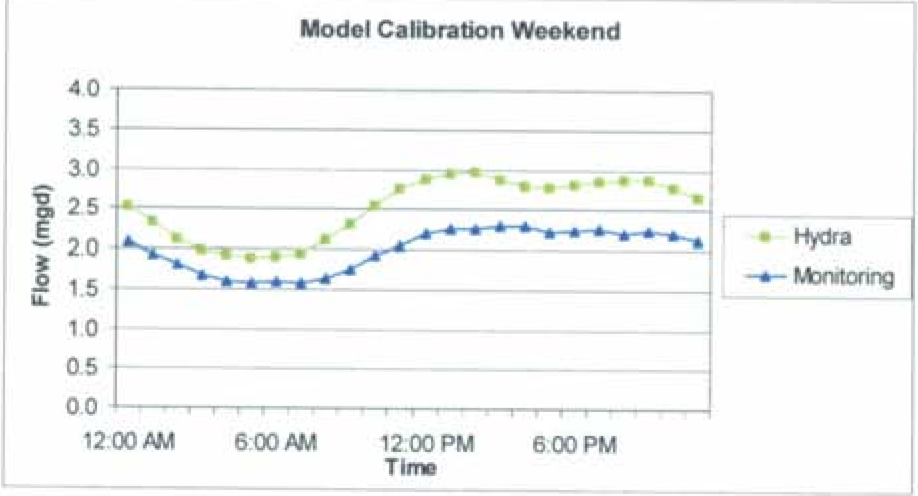


Table 12: Modeled Flow vs. Metered Flow at Wet Weather Flow Monitoring Site 12

	Peak		Average	
	mgd	%	mgd	%
Weekday	-0.9447	1.8	-0.8421	30.5
Weekend	-0.6796	1.4	-0.5234	22.8
Criteria		**20**		**10**

COMMENT: Similar to Site 8, Site 12 corresponds to an industrial area that has been considerably impacted by the economic downturn, with an occupancy rate that has dropped significantly between June 2001 and Winter 2001/2002. As a result the average modeled flow (based on 100% occupancy and June 2001 flow data) is significantly higher than the average monitored during winter 2001/2002. For the purpose of this Master Plan, it was decided to use the modeled values.

HYDRA Run Reference

Folder
E:\A. Projects\051-4 Milpitas Wet Weather Monitoring\B. Project Work\Hydra\3. 2004 Calibration\09. RDII Run 4

Run
04CAGII4.run
(2004 Calibration - RDII - 2/2/04 Storm - Run 4)

Base flow
BFWD01.FLO (Hydra) used in final 2003 Master Plan runs

GWI & RDI/I
DEFECTS9.FLO

Storm
2_2_04Storm.STO
(10 yr, 28 hours, lag = 9.0 hours)

Collection System
SY_2004
Pipe "n" = 0.013
Modified all diversions modeling criteria per Flow Diversions TM (September 2002); except DIV02 not functioning properly (12" line towards West is capped or plugged per Steve Smith).
Modified system per model acceptability review TM and additional troubleshooting
Updated model with 2004 surveyed data for 36 manholes (Surveyed information in Appendix xxx??? Or reference how the data was transfer to City)

HYDRA Calibration Run Results

Figures 1, 6, 7, 9, 10, 11, and 12 compare weekday modeled flow with flow measured at each 2004 wet weather flow monitoring site for Monday, February 2, 2004, during a significant storm event. Figure 8 of the Main Lift Station compares weekday modeled flow at the main lift station with the summary of flows measured from Sites 1, 10, 11, and 12 for Monday, February 2, 2004, during a significant storm event. Tables 1, 6, 7, 9, 10, 11, 12, and Main Lift Station presents the calibration criteria and results for each flow monitoring site and downstream boundary flow calibration verification by comparing the average and peak hour modeled flow with the average and peak hour flow measured at each wet weather flow monitoring site.[1] Comments are included for specific flow monitoring sites where more explanation is needed.

[1] Refer to the Wet Weather Flow Monitoring TM (Appendix C) in the 2003 Sewer Master Plan for more discussion on flow monitoring sites and total downstream flow calibration

The Excel spreadsheet that served to generate these figures and tables is provided on a CD-ROM. It can serve for future calibration work.

The calibration results were verified with the February 16, 2004 storm. The results of the verification check are presented in the CD-ROM (file name.xls)

SITE 1

Figure 1: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 1

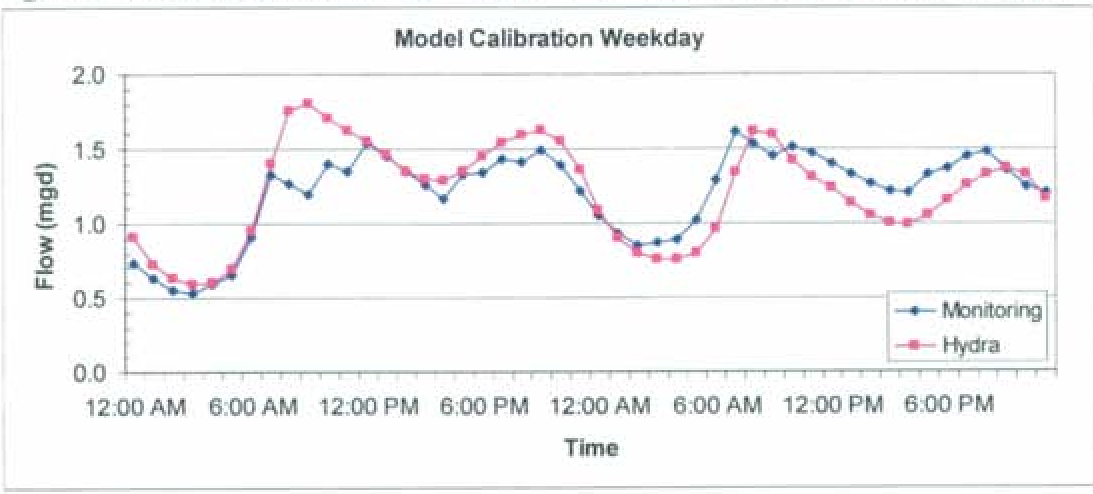


Table 1: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 1

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	0.4113	0.7	-0.2019	13.1	-0.0086	0.7
Criteria				**20**		**10**

COMMENT:

SITE 6

Figure 2: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 6

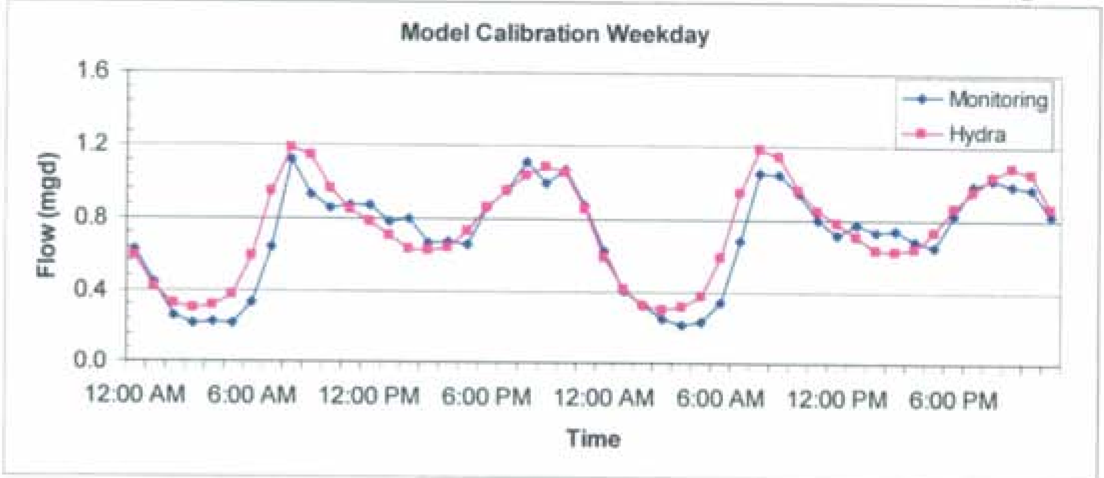


Table 2: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 6

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	2.0528	6.1	-0.0668	6.0	-0.0428	6.0
Criteria				**20**		**10**

COMMENT:

SITE 7

Figure 3: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 7

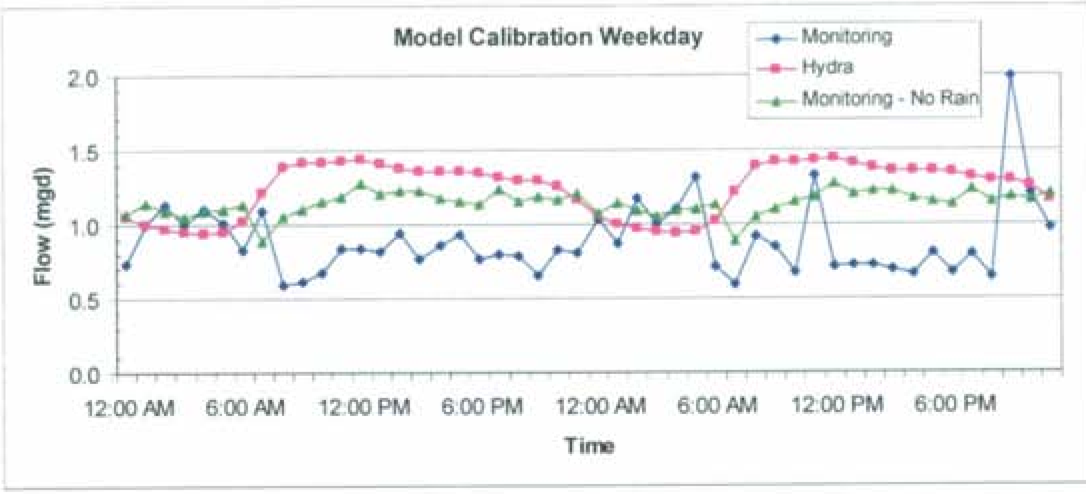


Table 3: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 7

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	16.9170	39.8	0.5485	48.4	-0.3524	41.5
No rain	4.6977	8.6	-0.1657	13.0	-0.0979	8.6
Criteria				**20**		**10**

COMMENT: Flow at Site 7 for the week of January 23-February 3, 2004, was abnormally low as compared with the average flow. This discrepancy is probably a result of incorrect flow meter calibration during the week of record. Measured flow data for average non-rain days were included for calibration instead.

SITE 9

Figure 4: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 9.

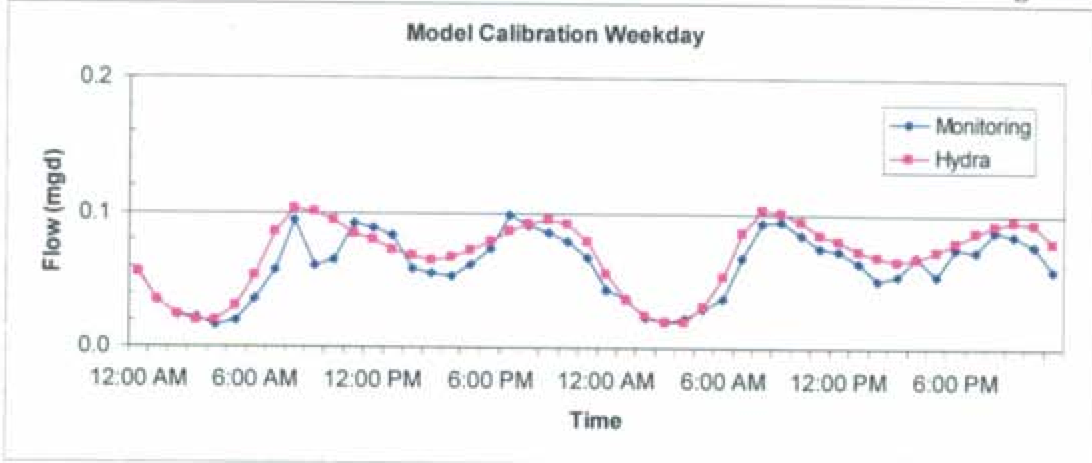


Table 4: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 9.

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	0.3899	13.4	-0.0046	4.7	-0.0081	13.5
Criteria				**20**		**10**

COMMENT: This site demonstrated flows in 2004 which could be abnormally low. During calibration, all GWI and RDI/I flows were removed, and the average flows were still not within the 10% calibration criteria. Hence, calibration beyond this would involve BWF factor adjustment and is, therefore, was not recommended. It is important to note that the Hydra model estimates flows slightly conservatively.

SITE 10

Figure 5: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 10.

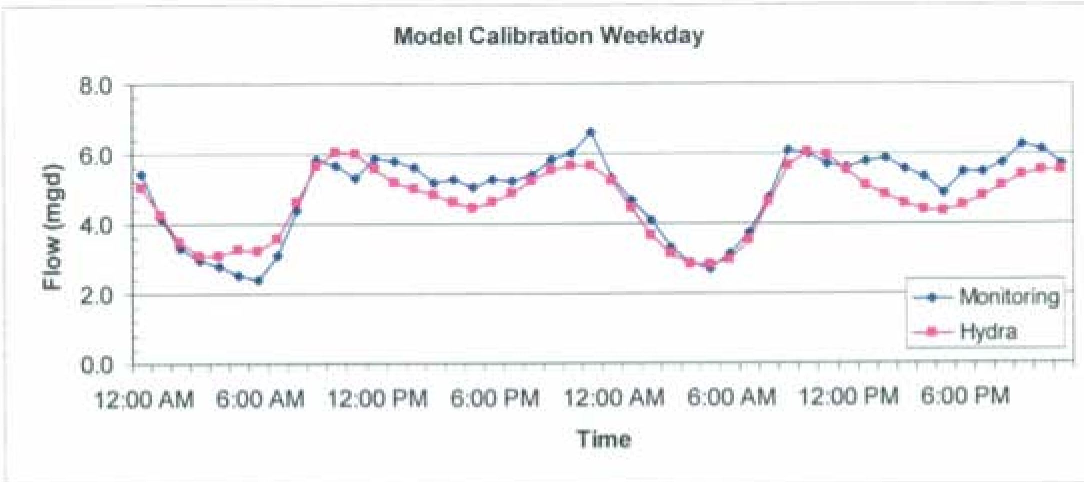


Table 5: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 10.

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	-12.2883	5.2	0.5570	8.4	0.2560	5.3
Criteria				**20**		**10**

COMMENT:

SITE 11

Figure 6: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 11.

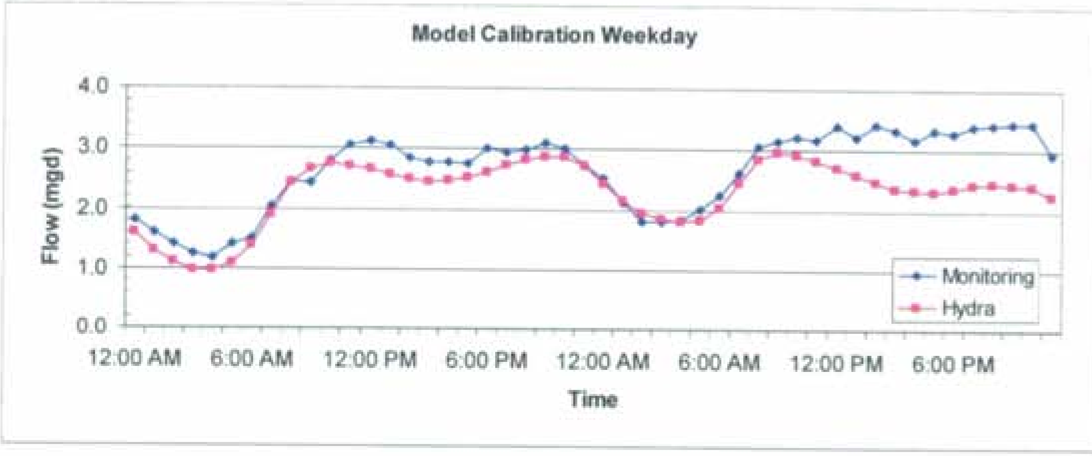


Table 6: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 11.

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	-17.5240	13.8	0.4883	15.7	0.3651	15.1
Criteria				**20**		**10**

COMMENT: This site is one of four downstream sites (i.e. sites 1, 10, 11, and 12) where flow records were used for total downstream flow calibration verification only. Hence, flow from this site consisted of flows from multiple basins and isolated data for each basin were not available to calibrate this site further.

SITE 12

Figure 7: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 12

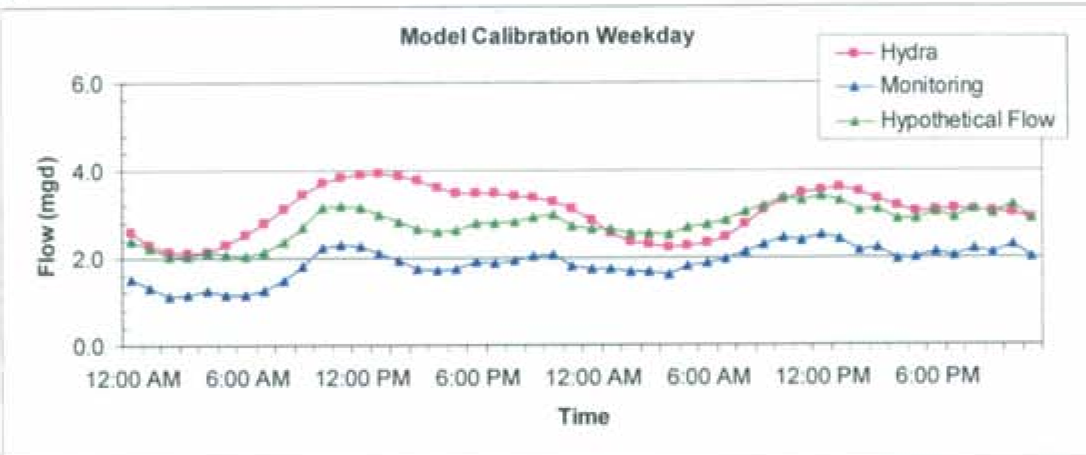


Table 7: Modeled flow versus metered flow at Wet Weather Flow Monitoring Site 12

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	55.9226	62.1	-1.4287	62.5	-1.1651	68.6
Hypothetical	12.7226	9.5	-0.5287	16.6	-0.2651	10.2
Criteria				**20**		**10**

COMMENT: This site is one of four downstream sites (i.e. sites 1, 10, 11, and 12) where flow records were used for total downstream flow calibration verification only. Hence, flow from this site consisted of flows from multiple basins and isolated data for each basin were not available to calibrate this site further.

Additionally, this site conveys flows from the McCarthy Ranch area where monitored flow in 2004 could be abnormally low due to the economic downturn in recent years. The hypothetical flow increased the monitoring flow uniformly by 0.9 mgd. Hence, calibration work beyond this would involve BWF factor adjustment and is, therefore, not recommended since it is assumed that the economic recovery in the future will increase flow to previous levels.

MAIN LIFT STATION

Figure 8: Modeled flow versus metered flow at the Main Lift Station

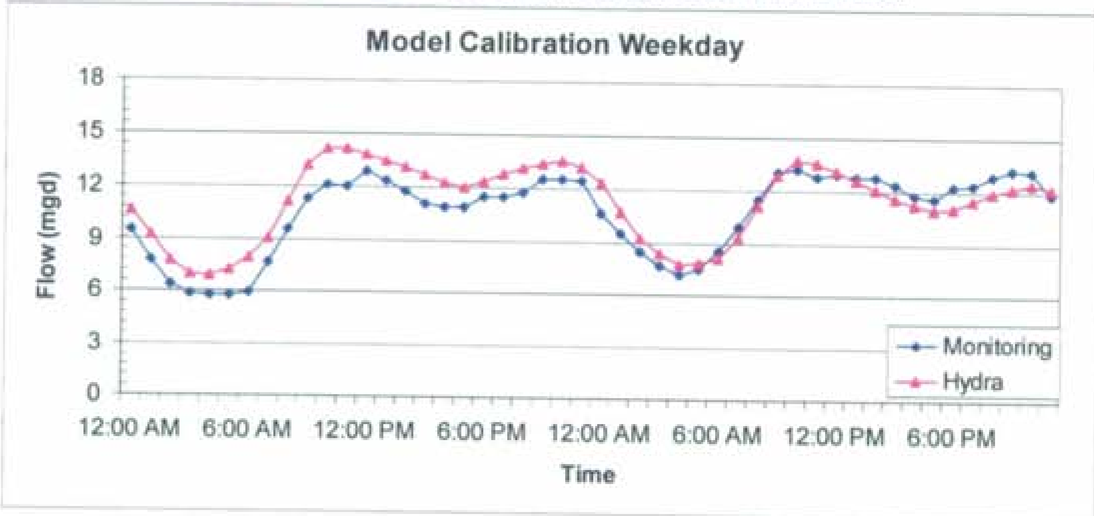


Table 8: Modeled flow versus metered flow at the Main Lift Station

	Total Volume		Peak		Average	
	mgd	%	mgd	%	mgd	%
Weekday	30.1385	5.9	-0.9756	7.6	-0.6279	6.2
Criteria				**20**		**10**

COMMENT:

APPENDIX G

GIS AND HYDRA FILES

(SEE CD-ROM)

APPENDIX H

SEWER PROJECT SUPPORTING INFORMATION

SEWER PIPELINES

Pipe Dia (in)	$/lf	Year/ SFENR CCI	$/LF/Dia (SFENR 7662)	Reference	Comments
Open Trench					
10	$124	1990/6000	$16	1994 Master Plan	Preliminary - pipe, installation, manholes, appurtenances, excavation, backfill, pavement removal, replacement, allowances for limited sheeting, dewatering, shoring, contractor overhead, profit, 30% included for engineering + administrative costs
12	$138		$15		
15	$150		$13		
18	$177		$13		
21	$198				
24	$225				
27	$244				
30	$265				
33	$290				
36	$318				
8	$160	1996/6500	$24	Newark Basin Master Plan	Includes: mobilization, traffic control, shoring, dewatering, manholes, pavement restoration for pipe depth between 10-15 ft
10	$170		$20		
12	$180		$18		
15	$185		$15		
18	$205		$13		
21	$230				
24	$260				
27	$290				
30	$315				
36	$360				
42	$415				
48	$470				
8	$151	2002/7684	$19	City of Milpitas Utility Depreciation Study	Includes: traffic control, trenching, pipe, installation, lateral, pavement cutting, removal, replacement
10	$167		$17		
12	$174		$14		
15	$200		$13		
18	$232		$13		
21	$253				
24	$291				
27	$321				
30	$360				
33	$401				
36	$445				
39	$382				
42	$411				
48	$454				
54	$501				
66	$598				
12	$156	2000/6474	$15	Sacramento Sewage Facilities Expansion MP	
15	$165		$13		
18	$198		$13		
21	$189				
24	$216				
27	$297				
30	$300				
8	N/A	2002/7662	$21	Average for each pipe size	N/A
10			$18		
12			$16		
15			$13		
18			$13		
21			$12		
24			$12		
Avg		2002/7662	$15	Average for all pipe sizes	
Pipe Bursting					
15	$161	2000/6474	$13	Sacramento Sewage Facilities Expansion MP	
18	$180	2000/6474	$12		
21	$206	2000/6474	$12		
27	$254	2000/6474	$11		
Avg		2002/7662	$12	Average for all pipe sizes	

ESTIMATED CAPITAL COST FOR RECOMMENDED PROJECTS

Hydra Pipe ID	Platt Pipe ID	Location	Existing Diameter (in.)	Length (ft)	Depth (ft)	Qdesign/Qfull	Initial Capacity Deficiency	Relief Diameter (in.)	Parallel Diameter (in.)	Recommended Diameter (in.)	Type	Unit Cost, ($/in.-dia/ft)	Estimated Cost, $1000: Construction	Contingency (30% of construction)	Implementation (30% of Construction + Contingency)	Total	Comments
NORTHERN AREA																	
Project 1-option 1																	
1508	*4602*	*btwn McCarthy and I-880*	*18*	*60*	*14.02*					30	Replace	15	27	8	11	46	Provisional Budget
1506	4601	Under I-880, from outfall	18	222	14.47	3.29	2002	30	27	30	Replace		266	80	104	450	Supplemental Cost Est
1494	15404	From outfall towards California Cir.	18	482	15.62	1.34	2002	21	15	24	Replace	15	173	52	68	293	
1491	15402	California Cir.	18	527	14.65	1.37	2002	21	15	24	Replace	15	190	57	74	320	
1488	15105	California Cir.	18	325	14.21	1.26	2002	21	12	24	Replace	15	117	35	46	198	
1485	15104	btwn California Cir./Calle del Sol	18	333	13.28	1.25	2002	21	12	24	Replace	15	120	36	47	203	
1480	*15103*	*btwn California Cir./Calle del Sol*	*18*	*294*	*13.81*					*24*	*Replace*	*15*	106	32	41	179	
1483	*15204*	*Jurgens Dr./Portifino Terrace*	*24*	*154*	*13.48*					*None Needed*							
1620	*15203*	*Jurgens Dr. btwn Portifino and Larkwood*	*24*	*186*	*12.29*					*None Needed*							
1478	15202	Jurgens Dr. btwn Larkwood and Gingerwood	15	279	10.32	1.35	2002	18	12	18	Replace	15	75	23	29	127	
TOTAL LENGTH (FT.)			2861.3	2521.3									1074	322	419	1815	
TOTAL LENGTH (MILES)				0.48													
Project 1-Option 2																	
1508	*4602*	*btwn McCarthy and I-880*	*18*	*60*	*14.02*					27	Replace	15	24	7	9	41	Provisional Budget
1506	4601	Under I-880, from outfall	18	222	14.47	3.29	2002	27	24	27	Replace		256	77	100	433	Supplemental Cost Est
TOTAL LENGTH (FT.)				282									280	84	109	474	
TOTAL LENGTH (MILES)				0.05													
Project 2																	
1632	15302	N. Milpitas Blvd./Washington Dr.	10	144	9.32	1.29	2002	12	8	12	Replace	15	26	8	10	44	
1500	14604	N. Milpitas Blvd. south of Homme Way	8	95	11.26	3.36	2002	15	12	15	Replace	15	21	6	8	36	
423	14603	N. Milpitas Blvd. btwn Jason and Homme	8	224	10.18	1.61	2002	10	8	10	Replace	15	34	10	13	57	
426	14602	N. Milpitas Blvd. north of Homme Way	8	169	9.32	1.36	2002	10	6	10	Replace	15	25	8	10	43	
TOTAL LENGTH (FT.)				633									106	32	41	180	
TOTAL LENGTH (MILES)				0.12													
Project 3																	
79	14302	N. Milpitas Blvd. south of Dixon Landing Rd.	8	143	9.8	1.46	2002	10	8	12	Replace	15	26	8	10	44	
TOTAL LENGTH (FT.)				143													
TOTAL LENGTH (MILES)				0.03													
WESTERN AREA																	
Project 4																	
481	18114	Heath St. south of Marylinn Dr.	15	400	11.1	1.32	2002	18	10	18	Replace	15	108	32	42	183	
485	18401	Heath St. south of Marylinn Dr.	15	380	11.3	1.32	2002	18	10	18	Replace	15	103	31	40	173	
TOTAL LENGTH (FT.)				780									211	63	82	356	
TOTAL LENGTH (MILES)				0.15													
Project 5																	
401	19501	Abbott Ave. btwn Heath and Valley Way	15	456	7.1	1.24	2008	18	10	18	Replace	15	123	37	48	208	
404	*19503*	*Abbott Ave. btwn Valley Way and Calaveras*	*15*	*100*	*7.02*					18	Replace	15	27	8	11	46	
406	*19504*	*Abbott Ave. btwn Valley Way and Calaveras*	*15*	*233*	*7.28*					18	Replace	15	63	19	25	106	
1353	19605	Abbott Ave. btwn Valley Way and Calaveras	15	143	7.37	1.28	2002	18	10	18	Replace	15	39	12	15	65	
1355	*19607*	*S. Abbott Ave./Calaveras Blvd.*	*16*	*54*	*7.28*							15	0	0	0	0	
1357	19505	south of Calaveras Blvd. at S. Abbott	15	323	8.82	1.59	2002	18	15	18	Replace	15	87	26	34	147	
TOTAL LENGTH (FT.)				1254									339	102	132	572	
TOTAL LENGTH (MILES)				0.24													
CENTRAL AREA																	
Project 6																	
1055	32302	N. Milipitas Blvd. south of Silverlake Ct.	18	400	10.75	1.21	2018	21	10	21	Replace	15	126	38	49	213	
1057	32303	N. Mipitas Blvd. crossing Beresford Ct.	18	219	12.75	1.23	2002	21	12	21	Replace	15	69	21	27	116	
1062	32307	N. Milpitas Blvd. south of Beresford Ct.	15	220	11.75	1.19	2002	21	10	21	Replace	15	69	21	27	117	
1059	32602	N. Milpitas Blvd. south of Beresford Ct.	15	202	11.43	1.24	2002	18	10	18	Replace	15	55	16	21	92	
TOTAL LENGTH (FT.)				1040									319	96	124	538	
TOTAL LENGTH (MILES)				0.20													

ESTIMATED CAPITAL COST FOR RECOMMENDED PROJECTS

Hydra Pipe ID	Platt Pipe ID	Location	Existing Diameter (in.)	Length (ft)	Depth (ft)	Qdesign/Qfull	Initial Capacity Deficiency	Relief Diameter (in.)	Parallel Diameter (in.)	Recommended Diameter (in.)	Type	Unit Cost, ($/in.-dia/ft)	Estimated Cost, $1000 Construction	Contingency (30% of construction)	Implementation (30% of Construction + Contingency)	Total	Comments
													Estimated Cost, $1000				
Hydra Pipe ID	Platt Pipe ID	Location	Existing Diameter (in.)	Length (ft)	Depth (ft)	Qdesign/Qfull	Initial Capacity Deficiency	Relief Diameter (in.)	Parallel Diameter (in.)	Recommended Diameter (in.)	Type	Unit Cost, ($/in.-dia/ft)	Construction	Contingency (30% of construction)	Implementation (30% of Construction + Contingency)	Total	Comments
Project 7																	
1044	31313	Escuela Pkwy btwn N. Milpitas and Hamilton	10	302	10.48	1.26	2002	12	8	12	Replace	15	54	16	21	92	
776	*44117*	*Angus Dr. btwn Escuela and Dundee*	*10*	*208*	*10.47*					*None Needed*							
766	44401	Angus Dr. btwn Dundee and Santa Rita	8	341	11.37	1.25	2002	10	6	10	Replace	15	51	15	20	86	
764	44402	Angus Dr. btwn Dundee and Santa Rita	8	337	10.67	1.28	2002	10	6	10	Replace	15	50	15	20	85	
762	44403	Angus Dr. btwn Dundee and Santa Rita	8	350	10.88	1.42	2002	10	6	10	Replace	15	52	16	20	89	
760	44504	east of Santa Rita Rd. north of Gill Park	8	449	16.2	1.14	2002	10	6	10	Replace	15	388	116	151	656	Supplemental Cost Est
TOTAL LENGTH (FT.)				1779									542	163	211	916	
TOTAL LENGTH (MILES)				0.34													
LOWER HILLSIDE																	
Project 8																	
201	57106	Calaveras Blvd.at 680	12	20	12	1.35	2002	15	10	15	Replace	15	5	1	2	8	
TOTAL LENGTH (MILES)																	
Project 9																	
1119	57202	Calaveras Blvd./Calaveras Ct.	12	170	12.02	1.54	2002	15	10	15	Replace	15	38	11	15	65	
1117	57306	Calaveras Blvd. btwn Calaveras CL and Carne	12	301	16.87	1.48	2002	15	10	15	Replace	15	68	20	26	115	
1110	57312	Camegie Dr. south of Calaveras	10	352	15.22	1.50	2002	12	8	12	Replace	15	63	19	25	107	
1254	57317	Camegie Dr. north of Canton Dr.	10	359	11.75	1.49	2002	12	8	12	Replace	15	65	19	25	109	
TOTAL LENGTH (FT.)				1203									234	70	91	396	
TOTAL LENGTH (MILES)				0.23													
MIDTOWN SPECIFIC AREA																	
Project 10-Option 1																	
1292	34502	S. Main St. north of E. Curtis Ave.	18	561	9.07	1.57	2008	24	15	24	Replace	15	202	61	79	341	
1294	34506	S. Main St. north of E. Curtis Ave.	18	339	9.05	1.67	2008	24	18	24	Replace	15	122	37	48	207	
1296	35201	S. Main St. north of E. Curtis Ave.	18	331	8.39	1.43	2018	21	15	21	Replace	15	104	31	41	176	
1298	35205	S. Main St. north of E. Curtis Ave.	18	241	8.53	1.43	2018	21	15	21	Replace	15	76	23	30	128	
TOTAL LENGTH (FT.)				1472									504	151	197	852	
TOTAL LENGTH (MILES)				0.28													
Project 10-Option 2																	
New	New	Curtis Avenue btw S Main St and S Abel St		625	15.5		2008			18	New	15	169	51	66	285	
Project 11																	
258	35602	S. Main St. south of Great Mall Dr.	18	401	11.45	1.61	2018	24	18	24	Replace	15	144	43	56	244.1	
260	35603	S. Main St. south of Great Mall Dr.	18	190	11.72	1.57	2018	24	15	24	Replace	15	69	21	27	115.8	
262	36301	S. Main St./Great Mall Pkwy	12	369	14.37	4.64	2002	24	21	24	Replace	15	133	40	52	224.8	584.8
908	*36302*	*Great Mall Pkwy btwn S. Main and McCandless*	*15*	*198*	14.15					*None Needed*							
910	*36304*	*Great Mall Pkwy btwn S. Main and McCandless*	*15*	*168*	14.67					*None Needed*							
913	36305	Great Mall Pkwy btwn S. Main and McCandless	10	429	13.8	2.62	2002	15	15	15	Replace	15	96	29	38	163.1	
918	49101	Great Mall Pkwy/McCandless	10	495	13.05	2.56	2002	15	12	15	Replace	15	111	33	43	188.2	
915	49401	Great Mall Pkwy north of Centre Point Dr.	10	431	14.32	2.43	2008	15	12	15	Replace	15	97	29	38	163.8	
919	49501	Great Mall Pkwy south of Centre Pointe Dr.	10	465	14.82	2.83	2002	15	15	15	Replace	15	105	31	41	176.6	
921	49502	Great Mall Pkwy/Montague Expwy	10	451	16.42	2.08	2008	15	12	15	Replace	15	101	30	40	171.3	
923	49503	Monague Expwy/E. Capitol Ave.	10	80	15.21	1.3	2018	12	8	12	Replace	15	14	4	6	24.4	863.1
925	49505	Montage Expwy btwn Centre Point and E. Capi	10	385	12.01	1.3	2018	12	8	12	Replace	15	69	21	27	117.1	
934	*50201*	*Montage Expwy/Centerpointe Dr.*	*10*	*418*	6.19					12	Replace	15	75	23	29	127.2	
932	50202	Montage Expwy north of Sango Ct.	8	28	5.95	2.2	2018	12	10	12	Replace	15	5	2	2	8.5	
930	50203	Montage Expwy north of Sango Ct.	8	143	5.7	1.49	2018	10	8	10	Replace	15	21	6	8	36.3	
927	50204	Montague Expwy/Sango Ct.	8	183	5.03	1.38	2018	10	6	10	Replace	15	27	8	11	46.3	359.8
TOTAL LENGTH (FT.)				4468									1070	321	417	1808	
TOTAL LENGTH (MILES)				0.85													
Project 12																	
275	49601	Montague Expwy west of Gladding	10	395	8.89	1.21	2008	12	6	12	Replace	15	71	21	28	120	
TOTAL LENGTH (MILES)				0.07													
																7605	

APPENDIX I

WET WEATHER FLOW MONITORING PROGRAM (2004)

Purpose and Objective

The purpose of the 2002 wet weather wastewater flow monitoring program was to collect the data necessary to perform the following tasks:

- Estimate groundwater infiltration (GWI) and rainfall-dependent infiltration/inflow (RDI/I) components of the wastewater flow for representative sewer basins for input into the hydraulic model; and,
- Calibrate the dynamic hydraulic model for existing conditions (as of March 2004).

Introduction

As part of the 2001 dry weather flow monitoring program (RMC, October 2001), flow factors and diurnal flow patterns were developed and updated. These flow patterns were input to the hydraulic model to estimate the base flow production component of the wastewater flow. The next phase of work was to 1) estimate and input the GWI[1] and RDI/I[2] components of the wastewater flow under saturated soil conditions (worse case scenario), and 2) calibrate the model for existing conditions (as of March 2004).

Within the scope of the 2002 Sewer Master Plan, wet weather flow monitoring was performed. Unfortunately, a "typical" rainy season was not experienced; the rainfall was significantly less than normal, so it was determined that there were not enough representative data to develop and calibrate the GWI and RDI/I rates at that time. Subsequently, it was recommended that the City conduct a follow up program, which has culminated in the 2004 Sewer Master Plan Revision

Flow Monitoring Program

The City of Milpitas 2004 wet weather flow monitoring program consisted of 4 temporary flow meters installed for a three-month period in December 2003–March 2004. Three additional temporary flow meters were installed for a one-month period in January–February 2004. The following sections describe the different tasks that were involved as part of the flow monitoring program.

Site selection

An adequate number of flow meters should be installed at adequate sites to produce sound, exploitable data. Ideally, wastewater flows from each of the sewer basins should be measured separately. Due to the scope of the study and budget limitations, seven monitoring stations were selected to provide minimum information for estimating the I/I rates and calibrating the model. Table 1 summarizes information relevant to the monitored manholes. The monitoring sites can be found on Map 1 Appendix C of the 2004 Sewer Master Plan Revision.

[1] Groundwater infiltration (groundwater flow that enters the system consistently, 24 hours a day) is modeled in Hydra by inputting constant groundwater infiltration rates associated with different sewer basins or specific area of the system (e.g. old sewers, invert below groundwater table). GWI might vary hourly in Milpitas due to tidal influence. However, for the purpose of the Sewer Master Plan, this potential hourly fluctuation will not be represented in the model.

[2] Rainfall-dependent infiltration and inflow is modeled in Hydra by inputting the infiltration and inflow rates (both as a percent of the total rainfall volume) and the basic shape of the hydrograph, which differs from the shape of the hyetograph due to the delays caused by the percolation process, associated with different sewer basins.

Table 1: Wet Weather Flow Monitoring Sites

	Manhole Number[a]	Location	Pipe Size (Inches)	Sewered Area (acres)	Potential GWI	Potential I/I
1	15-4-02[b]	California Circle	18	500	Medium	Medium
6	58-5-01[c]	Dempsey Rd between Yosemite Dr and Edsel Dr	21	530	Low	High
7	35-2-01[c]	Main St between Curtis Av and Siphon under Hetch Hetchy aqueduct	18	550	Medium	Low
9	22-3-05[c]	Starlite Dr at Galaxy Ct cross-section	8	60	High	High
10	16-1-02[b]	California Circle at Cadillac Ct cross-section	42	Flow records will serve for total downstream flow calibration		
11	18-1-03[b,d]	Between Highway 880 and McCarthy Blvd	30	Flow records will serve for total downstream flow calibration		
12	7-3-03[b]	McCarthy Blvd between Ranch Dr and 30" sewer connection	36	Flow records will serve for total downstream flow calibration		

Notes:
1. Estimates for potential GWI and I/I are based on map of age of sewers provided by the City, critical areas identified by Public Works Department staff, and map of average groundwater level (Kennedy/Jenks Consultants, October 1999).

Footnotes:
a. Refers to the City of Milpitas Sewer System Nodal Map. The first two numbers correspond to the sheet number and quadrangle, respectively, in the City's Sewer System 1"=100' Maps.
b. These manholes were monitored for a three-month period, December 2003 – March 2004.
c. These manholes were monitored for a one-month period, January 2004 – February 2004.
d. This is not the manhole that was metered, but it is the closest manhole shown on the City of Milpitas Sewer System Nodal Map.

Sites 1, 6, 7, and 9 were selected to evaluate the GWI and RDI/I components of the wastewater flows associated with representative sewer basins. A total of 1,640 acres were metered at these sites. Sites 1, 10, 11 and 12 were specifically selected to calibrate the total downstream flow, as the meter at the main lift station does not provide hourly flow data necessary for calibrating the dynamic model. Site 9 was also monitored as part of the 2001 dry weather flow monitoring program. The dry and wet weather wastewater flow data for this site can be compared to identify potential changes in groundwater infiltration under unsaturated and saturated soil conditions.

Two rain gages were installed for the duration of the flow monitoring period:

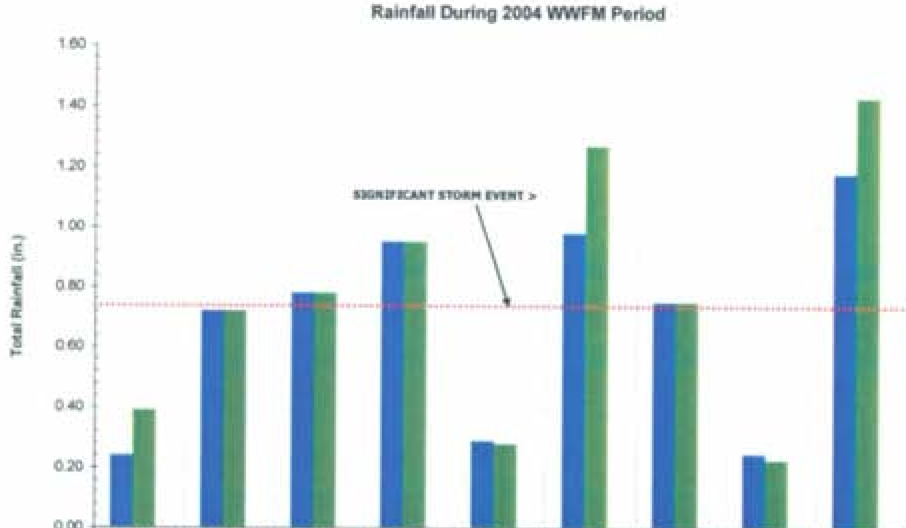
- Rain gage #1 was installed at the Public Works Department, located on North Milpitas Blvd, in the north-central section of the City (Valley Floor area); and,
- Rain gage #2 was installed at the Fire Station #2, located on Yosemite Dr, in the southeast section of the City (near the Hillside area).

Flow Data Analysis

Rainfall

A typical rainfall pattern was experienced during the winter 2003/2004 rainy season. Figure 2 illustrates rainfall events received during the 2004 wet weather flow monitoring period. A significant storm event is considered as one that produces greater than 0.75 inches of rainfall.

Figure 2: Rainfall events received during 2003/2004 wet weather flow monitoring period



	12/9 - 12/10	12/23 - 12/25	12/29	1/1-1/2	1/23 - 1/24	2/2 - 2/3	2/16 - 2/18	2/20 - 2/22	2/24 - 2/27
Total - Gage #2	0.24	0.72	0.78	0.95	0.29	0.98	0.75	0.25	1.18
Peak Hr - Gage #2	0.08	0.14	0.15	0.27	0.14	0.38	0.15	0.04	0.16
Total - Gage #1	0.39	0.72	0.78	0.95	0.28	1.27	0.75	0.23	1.43
Peak Hr - Gage #1	0.08	0.14	0.15	0.27	0.20	0.45	0.39	0.04	0.26

Storm Event Dates

Figure 2 shows that four of the nine discrete storm events that occurred during the December 2003 – March 2004 flow monitoring period were considered significant, where total rainfall exceeding 0.75 inches. The two most significant events totaled 1.27 and 1.43 inches of rain (at rain gage #1).

Groundwater Infiltration

Table 2 summarizes and compares estimated 2004 GWI for metered areas 1, 6, 7, and 9 with 2002 master plan value.

Table 2: Estimated GWI for Metered Areas 1 to 9

Site	Average Winter Water Use [a]	AWF over Monitoring Period		Estimated GWI			
		2002 Master Plan	2004 WWFM	2002 Master Plan		2004 WWFM	
	(mgd)	(mgd)		(mgd)	(gpad)	(mgd)	(gpad)
1	0.98	0.94	1.03	0.33 [b]	750 [c]	0.45 [d]	1,000 [c]
6	0.90	0.67	0.68	0.09	200	0.09	200
7	0.81	1.26	1.12	0.60	1100	0.38	700
9	0.13	0.09	0.06	0.03	450	0.01	150
Total/Average				1.05	625	0.93	500

Notes:

1. AWF: average daily wastewater flow; GWI: average daily groundwater infiltration; mgd: million gallons per day; gpad: gallons per acre per day; ABWF: average daily base wastewater flow; Min: minimum flow
2. The following industry-standard relationships were assumed for the flow data analysis:
   AWF = ABWF + GWI
   ABWF ~ 1.25 × (AWF – Min) in residential areas
   GWI ~ 0.9 × (Min – Continuous Flow) in commercial/industrial areas

Footnotes:

a. Estimated based on Nov 2000 – Feb 2001 water use records provided by the City of Milpitas.
b. Minimum flow averaged 0.45 mgd at Site 1, which represents approximately 50% of the average flows. A similar ratio was observed during the 1991 wet weather flow monitoring (Carollo Engineers, June 1994) at this site, which reduces the likelihood of a measurement error. High minimum flows could then be due to 1 relatively high residential wastewater flow at night, 2) high groundwater infiltration, and/or 3) industrial activities at night. Since industrial water use records total only 0.08 mgd and residential wastewater production has been calibrated, night flows are most likely due to groundwater infiltration. This assumption will be validated/revised during model calibration.
c. Based on 2001 dry weather flow monitoring, age of sewers and groundwater elevation in the area, GWI likely occurs only west of I-680. The metered area west of I-680 totals 440 acres.
d. Minimum flow averaged 0.56 mgd at Site 1, which represents approximately 50% of the average flows. A similar ratio was observed during the 1991 wet weather flow monitoring (Carollo Engineers, June 1994) and 2001 WWFM (RMC) at this site, which reduces the likelihood of a measurement error.

Minimum flow averaged 0.45 mgd at Site 1, which represents approximately 50% of the average flows. A similar ratio was observed during the 1991 wet weather flow monitoring (Carollo Engineers, June 1994) at this site, which reduces the likelihood of a measurement error. High minimum flows could then be due to 1 relatively high residential wastewater flow at night, 2) high groundwater infiltration, and/or 3) industrial activities at night. Since industrial water use records total only 0.08 mgd and residential wastewater production has been calibrated, night flows are most likely due to groundwater infiltration. This assumption will be validated/revised during model calibration.

The estimated GWI rates shown in Table 2 were initially input in the hydraulic model for GWI calibration. These rates were also extrapolated to areas that were not metered during the wet season, based on similarities in location, groundwater elevation and/or age of sewer as well as GWI rates established during dry weather flow monitoring. The calibrated GWI rates (and design GWI rates, if different) are documented after model calibration in the 2004 Sewer Master Plan Revision Report.

Rainfall-dependent Infiltration/Inflow

Table 3 presents the estimated RDI/I values and hydrograph shape for each metered areas for significant storm events during the flow monitoring period. Seven storm events with rain total ranging from 0.3 to 1.3 inches were evaluated. The estimated average RDI/I values, based on responses measured, ranged from 0.6 to 4.0 percent for various areas throughout the City.

Table 3: Estimated RDI-I in Metered Areas

Storm Characteristics		Storm Events							
		12/25/03	12/29/03	1/1/04	2/2-3/04	2/16/04	2/17/04	2/25/04	
Duration (hr)		11	12	4	27	8	19	47	na
Rainfall (in)		0.46	0.78	0.78	1.11	0.28	0.47	1.26	
Volume[a] (mg)		80	140	140	200	50	84	225	
Peak Hour (in)		0.13	0.15	0.27	0.42	0.14	0.15	0.21	
Site		**Estimated RDI-I**							**Average**
1		1.0	1.1	2.8	3.5	1.9	6.4	5.6	3.2
6		Non-metered period			0.3	1.4	0.4	Non-metered period	0.7
7					[c]	7.0	1.0		4.0
9					0.7	1.2	0.0		0.6
10-12[b]		Unreliable data[d]			2.7	3.2		3.2	3.0
Site		**Shape of Hydrograph**							**Average**
1	Lag-time 1[e]	5	1	2	1	0	0	3	2
	Lag-time 2[f]	4	1	2	2	10	9	1	4
	Lag-time 3[g]	1	8	17	43	13	39	24	21
6	Lag-time 1[e]	Non-metered period			0	0	1	Non-metered period	0
	Lag-time 2[f]				1	9	3		4
	Lag-time 3[g]				4	10	7		7
7	Lag-time 1[e]				[b]	6	0		3
	Lag-time 2[f]					9	2		6
	Lag-time 3[g]					15	0		8
9	Lag-time 1[e]				1	0	0		0
	Lag-time 2[f]				0	9	0		3
	Lag-time 3[g]				3	4	0		2

Notes:
1. The flow monitoring period for Sites 6, 7, and 9 were 1/9/2004 to 2/18/2004.
2. Sites 1, 10, 11, and 12 comprise of all flows in the City.

Footnotes:
a. Over entire sewered area (6,600 acres) for the City
b. RDI-I estimate represents Citywide RDI-I average.
c. Flows at Site 7 for the week of 1/23-2/3 was abnormally low compare with the average flow. Hence, a RDI-I estimate could not be established. For initial calibration purposes, an RDI-I rate of 3.0 was assumed.
d. Flows at Site 10 for the week of 12/30-1/12 and Site 11 for the week of 12/8-12/20 were abnormally low compare with the average flow. Hence, a RDI-I estimate could not be established.
e. Time between the beginning of the storm and the first signs of infiltration
f. Time between the peak of the storm hyetograph and peak infiltration
g. Time between the end of the storm and the end of infiltration

The February 2 -3, 2004, storm was used to calibrate the model since the total rainfall from this storm, at 1.11 inches, is close to the total design rainfall of 1.36 inches used in the 2003 analysis. The 2/16/04 storm was used to verify the model after calibration was completed. The calibration and verification results are presented in Appendix F.–The calibrated RDI/I rates (and design RDI/I rates) are documented after model calibration, in the 2004 Sewer Master Plan Revision Report.

Hydraulic Model Calibration

Data necessary for the hydraulic model calibration was collected at Sites 1, 10, 11 and 12. The baseflow was calibrated using the 2001/2002 wet weather flow monitoring data. GWI and RDI/I rates are calibrated using the 2003/2004 wet weather flow monitoring data.

ATTACHMENT A

Wet Weather Flow Monitoring – Winter 2003/2004

Conducted by E2 Consulting Engineers, Inc.

(See attached CD-Rom)